Biographical Sketch

OF

SIR ISAAC NEWTON,

TO WHICH ARE ADDED AUTHORIZED REPORTS OF

THE ORATION OF LORD BROUGHAM,

(WITH HIS LORDSHIP'S NOTES)

AT THE INAUGURATION OF THE STATUE AT GRANTHAM;

AND OF SEVERAL OF THE

SPEECHES DELIVERED ON THAT OCCASION.

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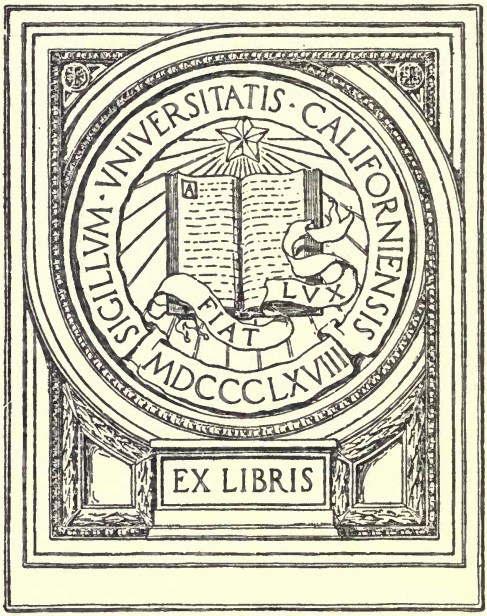

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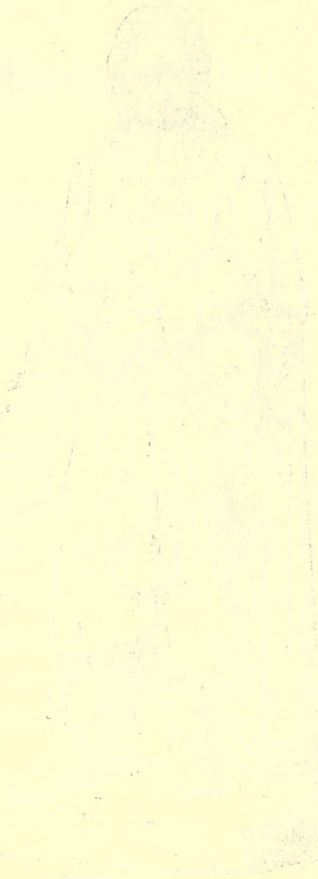

STATUE OF SIR ISAAC NEWTON,

AT GRANTHAM,

MODELLED BY W. THEED, ESQ.

A

Biographical Sketch

OF

SIR ISAAC NEWTON,

BY

E. F. KING, M. A.,

CLARE COLL. CAM.

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SECOND EDITION.

GRANTHAM: S. RIDGE & SON, HIGH-STREET.
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MDCCCLVIII.

PREFACE.

THE following brief sketch of the Life of Sir Isaac Newton has been written for the Inauguration of his Statue, and professes to be nothing more than a compilation from the larger works that have been published on the same subject. "Turnor's Grantham," "Sir David Brewster's Life of Sir Isaac Newton," "Newton's Correspondence with Cotes," by the Rev. J. Edleston, and "Professor de Morgan's Biography of Newton" in the Cabinet Portrait Gallery, are the volumes which have been chiefly consulted, and I here acknowledge my obligation for the large quotations which have been made from each of them.

E. F. K.

PREFACE TO THE SECOND EDITION.

THE first edition having been exhausted on the Inauguration day, a second is called for; and in issuing it, I gladly take advantage of the opportunity gratefully to acknowledge the kindness of Lord Brougham who furnished a copy of his Inaugural Oration, with notes, and corrected it in its progress through the press; and also of Dr. Whewell, the Rev. J. W. Inman, Sir B. C. Brodie, and Mr. Winter, who likewise revised the reports of the Speeches they delivered on that occasion.

E. F. K.

CONTENTS.

INTRODUCTION.

As the following Biographical Sketch has been written with especial reference to the Inauguration of the Statue of Sir Isaac Newton, at Grantham, on Tuesday the 21st of September, 1858, it will form an appropriate introduction to our pages if we give a brief account of how that statue originated.

The vacant space of ground at the south end of High-street, lately known as Wood Hill, but to which the original name of St. Peter's Hill has been properly restored, had long been considered a disgrace to the town, and at length a determination was come to that an attempt should be made to improve and ornament it. Accordingly, when the subject was discussed at a meeting of the Town Council, a suggestion was thrown out by F. Malim, Esq., that a statue in honour of Sir Isaac Newton would form a very great and a very appropriate ornament to the site. This suggestion met with a favourable reception, and an offer having been at once made by Thos. Winter, Esq., that if his colleagues would entrust the matter to him and give him full powers to proceed as he thought best, he would be willing to act as Honorary Secretary and would almost undertake that

the design should be successfully carried out; his proposal was forthwith adopted, and the members of the council immediately formed themselves into a Provisional Committee, with Mr. Winter as their Secretary, and gave him the powers he had required.

Armed with this authority, Mr. Winter, to whose energy and tact the complete success of the undertaking is greatly due, lost no time in going to London, and having obtained an introduction to Lord Rosse, the President of the Royal Society, his Lordship expressed himself as very favorable to the scheme, and sent Mr. Winter to Thomas Bell, Esq., the then secretary of the Royal Society and now President of the Linnæan Society, through whose intervention the subject was subsequently brought before the Royal Society. Acting under the advice of Mr. Bell, Mr. Winter next sought an interview with Lord Brougham, who at once entered most heartily into the matter and promised to do all he could to promote its success; a promise which his Lordship has most completely fulfilled.

On the 26th May 1853, Mr. Winter attended one of the council meetings of the Royal Society, and presented to that body a communication from the Town Council of Grantham, when the following resolution was entered upon the minutes of the Royal Society: "Resolved,—The President and Council of the Royal Society cannot but feel very warm sympathy with any proposal to do honour to the memory of Newton, and learn with great satisfaction the desire which is entertained by the inhabitants of Grantham, that a monument of him should be erected at a town so intimately connected with the place of his birth and early education; and will be happy to be further informed from time to time of the progress which has been made in the fulfilment of this design."

The project having thus received the sanction of the greatest scientific Society in the kingdom, the usual means were adopted to bring it before the public, with a view of obtaining subscriptions.

Her Majesty the Queen and the Prince Consort were graciously pleased to sanction the undertaking by their patronage, and to send a subscription of £100.

Major General the Hon. Sir Edward Cust, who has also been indefatigable in promoting the undertaking, kindly consented to act as General Treasurer; and the project having been advocated and accepted as a national work, it received, in a few months from its first publication, the sanction of most of the leading scientific and literary men of the day.

Such being the case, a general meeting of the subscribers was held on the 27th of September, 1854, in St. George's Hall, Liverpool, on the occasion of a sitting in that town of the British Association for the advancement of science. At this meeting, the Earl of Harrowby being in the chair, after a vote of thanks had been passed to her Majesty and the Prince Consort for their patronage, it was resolved that the memorial should be a bronze statue, and, among other business of minor importance, that there should be appointed two special committees of management, one for Grantham, with Lord Harrowby as its president, the other for London, presided over by Lord Brougham; that these two committees should, when the amount subscribed justified such a course, each select two gentlemen, who should nominate a fifth, and that the committee of five thus chosen should select an artist to execute the work.

In accordance with this resolution, the Earl of Harrowby, Sir Glynne Earle Welby, Bart., Major General the Hon Sir Edward Cust, Sir Charles Eastlake, and Robert Stephenson,

Esq., M. P., were appointed the committee of selection, and several of the leading sculptors of the day having been invited to compete for the design, the result was, omitting minor details, that the work was entrusted to Wm. Theed, Esq., whose established reputation as an artist of the highest class rendered him well worthy of the important task which he undertook to execute.*

Nor have the expectations which the fame of Mr. Theed were calculated to raise been in any way disappointed, for we think it will be generally admitted that he has produced a work which is highly creditable to himself, and a testimonial not unworthy even of the great philosopher in whose honour it is erected. As a tribute to one of the greatest of England's Worthies, it is a work of which the nation may be proud; to the subscribers and to all concerned, it is in every way a credit; and as an ornament to the town of Grantham, it speaks well for the good taste and liberality of the inhabitants.

The statue represents the philosopher in the costume of the period, and in the gown of a Master of Arts in the act of lecturing, and his right hand is pointing to a celebrated diagram taken from the Principia, drawn upon the scroll in his left hand.

The likeness is from the well known mask of Sir Isaac's face taken after death, and from the portrait bust by Roubiliac.

The figure of Sir Isaac is 12 feet high, and weighs upwards of two tons, about half of which quantity was presented, in the shape of old cannon, by Her Majesty's Government. It was cast at the foundry of Messrs. Robinson & Cottam, of Pimlico, and does them the highest credit. As a specimen of clean casting

* Mr. Theed was a student in Rome for twenty-two-years, where he had the constant advice of the famous Thorwaldsen, the Danish sculptor, as also that of our justly celebrated countryman, Gibson.

with sharp outline, it cannot be surpassed; a result to be attributed partly to the skill of the mould-makers and founders, and partly to the care which Mr. Theed is known to bestow on his models.

The pedestal on which the figure stands is from a design by Mr. Theed; it is 14 feet high, and was cut in Anglesey by Mr. Rogers, of Park Hill, from the celebrated marble quarries near Holyhead. The total height of the pedestal and figure together is 26 feet.

The statue faces the west, looking on the road along which Sir Isaac must have passed whenever he came to Grantham.

The total amount subscribed is £1630, of which £600 was contributed by the inhabitants of Grantham and the neighbourhood.

The site has been presented by the Town Council, and it is almost needless to state, that all the gentlemen who have successively presided over that body since the project was first formed, have invariably given it their best assistance.

MANOR HOUSE, WOOLSTHORPE.

A BIOGRAPHICAL SKETCH

OF

Sir Isaac Newton.

CHAPTER I.

FROM HIS BIRTH, TO COMING TO GRANTHAM.

This illustrious Philosopher, the scion of an ancient family settled at Woolsthorpe, was born in the manor-house there between one and two o'clock in the morning of Christmas-day, 1642.

Woolsthorpe is a hamlet within half a mile to the north-west of Colsterworth,* and about eight miles to the south of Grantham. The house in which Sir Isaac was born can easily be distinguished from the high road just before entering Colsterworth to the right hand, by any one travelling from Grantham. Dr. Stukeley, who visited it in 1721, gives the following account of it in a letter to Dr. Mead, dated Grantham,

* Colsterworth and Woolsthorpe were within the ancient limits of the Soke of Grantham until they were severed by the Municipal Reform Act in 1835.

26th June, 1727, "'Tis built of stone, as is the way of the country hereabouts, and a reasonable good one. They led me up stairs and showed me Sir Isaac's study where I suppose he studied when in the country in his younger days, or perhaps when he visited his mother from the University. I observed the shelves were of his own making, being pieces of deal boxes which probably he sent his books and clothes down in on those occasions. There were some years ago two or three hundred books in it of his father-in-law, Mr. Smith, which Sir Isaac gave to Dr. Newton of our town, (Grantham)." John Newton, the heir at law, who succeeded to the manor and estates after the death of Sir Isaac in 1727, sold them in 1732 to Edmund Turnor, Esq , of Stoke Rochford, in the possession of whose descendants they have ever since remained. The true English spirit, liberality, and good taste of the successive possessors of the Turnor estates are so well known that it is almost unnecessary to say the house in which Sir Isaac was born has been most religiously preserved and protected. It was thoroughly repaired in 1798, and since that time has been further restored as occasion required. The arrangement of the rooms is unaltered, and, with the exception of such renovations as were necessary to keep it in good order, it remains the same as it was when Sir Isaac was born. In the room where his birth took place, Mr. Turnor, in 1798, put up a marble tablet, which still remains there, with the following inscription :—

Sir Isaac Newton, son of Isaac Newton, Lord of the Manor of Woolsthorpe, was born in this room on the 25th of December, 1642."

> Nature and nature's laws lay hid in night
> God said, "Let Newton be," and all was light.

According to Sir David Brewster, the following lines have been written on the house :—

> Here nature dawned, here lofty wisdom woke,
> And to a wondering world divinely spoke.
> If Tully glowed when Phædrus's steps he trode,
> Or fancy formed philosophy a God :
> If sages still for Homer's birth contend,
> The sons of science at this dome must bend.
> All hail the shrine ! All hail the natal day,
> Cam boasts his noon,—this *Cot* his morning ray.

The celebrated apple tree,* the fall of one of the apples of which is said to have turned the attention of Newton to the subject of gravitation, was so decayed that it was taken down by Mr. Turnor in 1820, and the wood of it carefully preserved ; and of the two dials which he carved on the walls of the house, the one that was the most legible was removed in 1844 on the stone on which it was cut, and presented by the Rev. C. Turnor, to the Museum of the Royal Society. The dial was traced on a large stone in the south wall at the angle of the building, and rather less than six feet from the ground. The name "Newton," with the exception of the first two letters which have been obliterated, may be seen under the dial in rude and capital letters. It is framed in glass for preservation, having been presented in that state by Mr. Turnor. The other dial may still be seen in its original position. Sir Isaac carved the dials when he was probably about fourteen years of age.

As Dr. Stukeley said of it in 1727, "Such is the place that produced the greatest genius of the human race. He was born in the manor-house, which was the family estate, and where they hold a court leet and court baron." Any one who wishes

* A slab of the wood taken from this tree at the time of its fall is in the possession of Mr. Winter of Grantham, to whom it was given by C. Turnor, Esq.

to visit it, can inspect it on application to the present tenant, Mr. Woolerton. Visitors, who are strangers to the district, should take a conveyance from Grantham ; the journey to Woolsthorpe and back, with the inspection of the house, will occupy less than three hours. About three miles from Grantham they will see to the left, and close to the road, the church of Great Ponton, the tower of which is justly admired for its proportion and elegance. The arms of Ellys, and the motto "Thynke and Thanke God of all," are carved in various parts of it; the whole is embattled and covered with lead. Mr. Ellys, who built it, is reported to have sent his wife a cask inscribed "Calais sand," without any further mention of its contents. At his return to Ponton, he asked her what she had done with it, and found she had put it in the cellar; he then acquainted her that it contained the bulk of his riches ; with which (being issueless) they mutually agreed to build a church in thanksgiving to God for having prospered them in trade. A short distance further on from Ponton, the road skirts the park of Christopher Turnor, Esq.; it is to the right-hand, and the turrets of his magnificent mansion can just be descried above the trees. In less than a mile, you come to the handsome baronial residence of Sir Montague Cholmeley, Bart., with its park, woods, and terraced gardens, which can be seen from the road on the left. Then Woolsthorpe, a quarter of a mile from the road on the right.

Sir Isaac Newton was the only child of his father Isaac Newton, and posthumous, inasmuch as he was born nearly three months after the death, in the thirty-seventh year of his age, of his father, who was descended from the eldest branch of the family of Sir John Newton, Bart., and was lord of the manor of Woolsthorpe. The family came thither from Westby

in Lincolnshire, but originally from Newton in Lancashire, from whence they probably took their name. His mother was Hannah Ayscough, (at a later period corrupted into Askew) of an ancient and honourable family, the daughter of James Ayscough of Market Overton, Rutland.

In the same year in which Sir Isaac was born, there was the commencement of the Civil War between the Parliament and Charles the First, who raised his standard at Nottingham Castle, on August the 22nd. The battle of Edgehill was fought on October the 23rd. In the early part of the same year, the great Astronomer Galileo died, aged 78.

Having thus cleared the way, we will return to the birth of Sir Isaac, and start fair from the commencement of his life. It is said that when he first came into the world he was such a puny and diminutive infant that he might have been contained in a quart mug. This was most likely a mere figure of speech descriptive of his being a very small baby, for the quart mug seems to be the general household standard in Lincolnshire for undersized mannikins ; but be this as it may, it is tolerably certain that the amount of vitality in him was exceedingly small, and that two women who were sent to Lady Pakenham's, at North Witham, to obtain some tonic medicine for him, did not expect to find him alive on their return. Providence, however, happily for mankind, willed it otherwise, and the infant, which at first seemed scarcely able to exist from minute to minute, became in due time the accurate calculator of vast spaces of time, and an old man of eighty-five years.

The manor of Woolsthorpe, purchased by Sir Isaac's grandfather in 1632, from Robert Underwood, was worth only £30. a year, but his mother possessed a small estate at Sewstern, near Woolsthorpe, which was worth about £50 a year, and the

£80. thus made up, together with what she could obtain by the cultivation of the little farm on which she resided, was all the income the widow possessed for the maintenance of herself and son, and for his education. It was the smallness of her income we suspect that led Mrs. Newton to listen favourably to a proposal for a second marriage, and this idea is strongly supported by the following account which Mr. Conduitt, a nephew by marriage of Sir Isaac, writing circa, 1728, says he received from "Mrs. Hutton, whose maiden name was Ayscough." "Mr. Smith, a neighbouring clergyman, who had a very good estate, had lived a bachelor till he was pretty old, and one of his parishioners advising him to marry, he said he did not know where to meet with a good wife. The man answered, the widow Newton is an extraordinary good woman. But, saith Mr. Smith, how do I know she will have me, and I don't care to ask and be denied; but if you will go and ask her, I will pay you for your day's work. He went accordingly. Her answer was, she would be advised by her brother Ayscough. Upon which Mr. Smith sent the same person to Mr. Ayscough on the same errand, who upon consulting with his sister, treated with Mr. Smith, *who gave Isaac a parcel of land, being one of the terms insisted on by the widow if she married him.*" If the above account is true, and we see no reason to doubt it, it is clear that prudential considerations had a deal to do with the second marriage of the widow Newton; but whatever her motives may have been, it is certain that she had a second husband, having been married on the 27th of January, 1645, to the Rev. Barnabas Smith, rector of North Witham. The issue of this marriage was a son and two daughters, Benjamin, Mary, and Hannah Smith, from whom were descended the four nephews and four nieces who inherited Sir Isaac's personal estate.

The young Isaac was thus not merely the only and posthumous child of his father, but, by the marriage of his mother, he was deprived of the care and supervision of his remaining parent when he was very little more than two years of age. Of his early childhood we have very few particulars; but it appears, that on the marriage of his mother he fell to the care of his grandmother, the wife of James Ayscough, and a daughter of Mr. Blythe of Stroxton, who came to reside at Woolsthorpe for that especial purpose. At the usual age, Isaac was sent to two little day-schools at Skillington and Stoke, and he remained there till he was twelve years of age, picking up such rudiments of reading, writing, and arithmetic as were to be found at such seminaries.

During the period of his childhood at Woolsthorpe, many events of great national importance took place,—the death of Hampden; the Solemn League and Covenant; the defeat of the king's troops near Grantham, by Cromwell; the execution of Archbishop Laud; the battle of Naseby; the siege and surrender of Belvoir Castle: the surrender of the king to the Scottish army before Newark; Charles the 1st beheaded, (Isaac Newton six years old at that time); the Commonwealth proclaimed; the execution of the Marquis of Montrose; the battle of Dunbar; the battle of Worcester; and Cromwell declared Lord Protector. Besides these national events, we may remark that in the year after Isaac Newton was born, Torricelli invented the barometer. In 1645, Grotius died at Rostock, and in the same year, the screw press for coining was introduced into the mint at Paris.

CHAPTER II.

AT SCHOOL AT GRANTHAM.

Having passed his years of childhood at Woolsthorpe, partly under the guardianship of his uncle, the Rev. William Ayscough, but chiefly under the care of his grandmother, Isaac was sent at the age of twelve, in 1655, to the Grammar School, at Grantham; and in order that he might participate in the full advantages of that liberally endowed institution by becoming a free town boy, he was boarded at the house of Mr. Clark, an apothecary in the town, whose house stood next door to the George Inn, on the north: the George was rebuilt 1711. He appears to have lodged with Mr. Clark the whole time he was in Grantham, and the grandson of that gentleman exercised the same profession there at the time of Newton's death in 1727. During the whole period too that he was at school, he had the advantage of being under the same preceptor, Henry Stokes, who was head-master of the school from 1649 to 1663. His school-life was chiefly remarkable for the decided turn he manifested for mechanics and carpentering, and Dr. Stukeley, writing in 1727, says "Every one that knew Sir Isaac, or have heard of him, recount the pregnancy of his parts when a boy, his strange inventions, and an extraordinary inclination for

mechanics. That instead of playing among the other boys, when from school, he always busied himself in making knick-knacks and models of wood in many kinds. For which purpose he had got little saws, hatchets, hammers, and all sorts of tools, which he would use with great dexterity. In particular they speak of his making a wooden clock. About this time, a new windmill was set up near Grantham, on the way to Gunnerby, which is now demolished, this country chiefly using water-mills. Our lad's imitating spirit was soon excited, and by frequently prying into the fabric of it, as they were making it, he became master enough to make a very perfect model thereof, and it was said to be as clean and curious a piece of workmanship as the original. This sometimes he would set upon the house-top, where he lodged, and clothing it with sail-cloth, the wind would readily turn it; but what was most extraordinary in its composition was, that he put a mouse into it, which he called the miller, and that the mouse made the mill turn round when he pleased; and he would joke too upon the miller eating the corn that was put in. Some say that he tied a string to the mouse's tail, which was put into a wheel, like that of turnspit dogs, so that pulling the string made the mouse go forward by way of resistance, and this turned the mill. Others suppose there was some corn placed above the wheel, this the mouse endeavouring to get to, made it turn. Moreover Sir Isaac's water clock is much talked of. This he made out of a box he begged of Mr. Clark's (his landlord) wife's brother. As described to me, it resembled pretty much our common clocks and clock cases, but less; for it was not above four feet in height, and of a proportionable breadth. There was a dial-plate at top with figures of the hours. The index was turned by a piece of wood, which either fell or rose

by water dropping. This stood in the room where he lay, and he took care every morning to supply it with its proper quantity of water; and the family upon occasion would go and see what was the hour by it. It was in the house long after he went away to the University. * * * These fancies sometimes engrossed so much of his thoughts that he was apt to neglect his book, and dull boys were now and then put over him in form. But this made him redouble his pains to overtake them, and such was his capacity, that he could soon do it, and outstrip them when he pleased; and it was taken notice of by his master. Still nothing could induce him to lay by his mechanical experiments: but all holidays, and what time the boys had allowed to play, he spent entirely in knocking and hammering in his lodging room, pursuing that strong bent of his inclination, not only in things serious, but ludicrous too, and what would please his school-fellows as well as himself; yet it was in order to bring them off from trifling sports, and teach them, as we may call it, to play philosophically, and in which he might willingly bear a part; and he was particularly ingenious at inventing diversions for them, above the vulgar kind. As for instance, in making paper kites, which he first introduced here. He took pains, they say, in finding out their proportions and figures, and whereabouts the string should be fastened to the greatest advantage, and in how many places. Likewise he first made lanterns of paper crimpled, which he used to go to school by in winter mornings, with a candle, and tied them to the tails of the kites in a dark night, which at first affrighted the country people exceedingly, thinking they were comets. It is thought that he first invented this method; I can't tell how true. They tell us too how diligent he was in observing the motion of the sun, especially in the yard of

the house where he lived, against the walls and roofs, wherein he would drive pegs, to mark the hours and half-hours made by the shade, which by degrees of some years' observations, he had made very exact, and anybody knew what o'clock it was by Isaac's dial, as they ordinarily called it; thus in his youngest years did that immense genius discover his sublime imagination, that since has filled, or rather comprehended the world." As a confirmation of what Dr. Stukeley says, and as a proof that he was extremely inattentive to his studies, we have the following anecdote which Sir Isaac himself told to Mr. Conduitt, and which we will give in the words of Sir David Brewster. "When he was the last in the lowermost form but one, the boy next above him, as they were going to school, gave him a kick on the stomach, which occasioned a great degree of pain. As soon as the scholars were dismissed, Newton challenged the boy to fight, and for this purpose they went into the churchyard. The schoolmaster's son came up to them during the fight, and clapping one on the back and winking to the other, encouraged them both to continue the encounter. Though Sir Isaac was not so robust as his antagonist, yet he had much more spirit and resolution, and therefore succeeded in the combat, beating his opponent till he declared he would fight no more. The schoolmaster's son, who seems to have been an amateur in the art, told Sir Isaac that he must treat the other as a coward by rubbing his nose against the wall. The victor accordingly took the advice, and dragging his victim by the ears, thrust his face against the wall of the church. The success which thus attended his first struggle for superiority, induced him to repeat it in a better cause. Although vanquished in the churchyard, his antagonist still stood above him in the school, a victory more honourable than that which

Newton had achieved; and though the schoolmaster and his son would have given a different decision on the relative merits of the youthful combatants, yet Newton took the right view of his own position, and resolved to possess the moral as well as the physical superiority. He accordingly exerted himself in the preparation of his lessons, and after many a severe struggle in which he and his adversary were alternately successful, he not only gained the individual victory, but rose to the highest place in the school.

In order that he might carry out his mechanical designs with success, it was necessary that he should possess to a certain extent an acquaintance with the art of drawing, and accordingly we find that he applied himself to acquire it. Dr. Stukeley says that he was told by Mr. Clark, the grandson of the gentleman with whom Sir Isaac boarded, that "the room where Sir Isaac lodged, was his lodging room too when a lad, and that the whole wall was still full of the drawings he had made upon it with charcoal, and so remained till pulled down about sixteen years ago. * * * They were birds, beasts, men, ships, and mathematical schemes, and very well designed." Dr. Stukeley also says, "The lad was not only very expert with his mechanical tools, but he was equally so with his pen; for he busied himself very much in drawing, which I suppose he learnt from his own inclination and observation of nature. By enquiry I was informed that one old Barley (as he was called) was his writing master, who lived where is now the Millstone alehouse, in Castle street; but they don't remember that he (Barley) had any knack in drawing. However, by this means, Sir Isaac furnished his whole room with pictures of his own making, which probably he copied from prints, as well as from life. They mention several of the king's heads, Dr. Donne,

and likewise his master Stokes. Under the picture of King Charles 1st, he wrote these verses, which I had from Mrs. Vincent, by memory, who fancies he made them; if that be true, it is most probable he designed the print too, which is common to this day.—

A secret art my soul requires to try,
If prayers can give me what the wars deny.
Three crowns distinguish'd here in order do
Present their objects to my knowing view.
Earth's crown, thus at my feet, I can disdain,
Which heavy is and at the best but vain.
But now a crown of thorns I gladly greet,
Sharp is this crown, but not so sharp as sweet.
The crown of glory that I yonder see
Is full of bliss and of eternity.

These pictures he made frames to himself, and coloured them in a workmanlike manner."

In 1656, his mother again became a widow by the death of her second husband the Rev. B. Smith, and in consequence of this event, she left the rectory at North Witham, and once more took up her residence at Woolsthorpe. At this time Isaac was fourteen years of age, and as no profession seems to have been talked of for him, it is most likely that she intended to bring him up as a farmer and grazier. At all events, she recalled him from Grantham, and he at once entered upon the usual occupations of a farm. One of his duties was to go to Grantham on Saturdays, sell agricultural produce, and bring back household requisites. Till he was supposed to be able to transact business himself, he was accompanied on those occasions by an old servant, and as soon as they had arrived at their inn, the Saracen's Head in Westgate, he used generally to leave all the marketings to be done by the servant, and betake himself straightway to his garret at Mr. Clark's, and there

occupy himself with his old books till it was time to go home again. Sometimes, however, he did not even come as far as Grantham, but left the servant to journey on alone, while he sat down under a hedge on the road-side and devoted himself to some favourite book till his companion returned in the afternoon. It was about this time that he made one of his earliest scientific experiments, for he told Mr. Conduitt in after-life that "In 1658, on the day of the great storm, when Cromwell died, and when he himself had just entered his sixteenth year, in order to determine the force of the gale, he jumped first in the direction in which the wind blew, and then in opposition to the wind; and after measuring the length of the leap in both directions, and comparing it with the length to which he could jump on a perfectly calm day, he was enabled to compute the force of the storm."

With such tastes and habits in its manager, the farm was not likely to prosper, and at length his uncle the Rev. William Ayscough, rector of Burton Coggles, having caught Newton seated under a hedge occupied in the solution of a mathematical problem, the neglected condition of the estate rendered his mother the more ready to listen to her brother's urgent advice that Isaac should be sent to school again, and have all the advantages which a good education can bestow. Accordingly he returned to Grantham in 1660, and again attended the grammar school, lodging as before with Mr. Clark, whose brother was usher at the school at the time; he remained there till the time he went up to Cambridge in 1661, and his studies, of which we have no record, were no doubt such as were usually pursued at that period by those who were preparing themselves for the University of Cambridge.

During the time Sir Isaac was at Grantham, he formed a

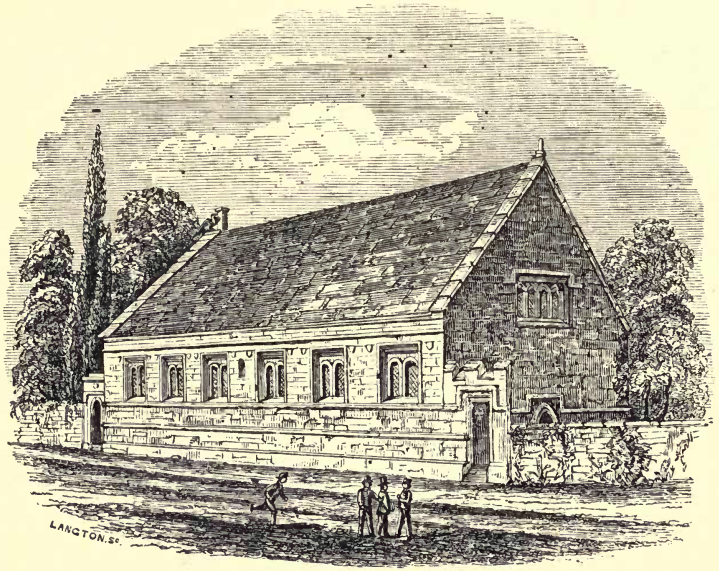
friendship which would probably have led to a marriage, had not the straightened means of both parties prevented it. Dr. Stukeley thus alludes to the Lady, with whom he appears to have been acquainted at the latter part of her life. "Mrs. Vincent is a widow gentlewoman living here, (Grantham) aged 82. Her maiden name was Storey, sister to Dr. Storey, a physician of Buckminster, near Colsterworth. Her mother, who was a handsome woman, was second wife to Mr. Clark, the apothecary, where Sir Isaac lodged, so that she lived with him in the same house all the time of his being at Grantham, which was about seven years. Her mother and Sir Isaac's mother were intimately acquainted, which was the reason of his lodging at Mr. Clark's. * * * * She says Sir Isaac was always a sober, silent, thinking lad, and was never known scarce to play with the boys abroad, at their silly amusements; but would rather choose to be at home, even among the girls, and would frequently make little tables, cupboards, and other utensils for her, and her playfellows, to set their babies and trinkets on. She mentions likewise a cart he made with four wheels, wherein he would sit, and by turning a windlass about, he could make it carry him round the house where he pleased. Sir Isaac and she being thus brought up together, 'tis said that he entertained a love for her, nor does she deny it; but her portion not being considerable, and he being a fellow of a college, it was incompatible with his fortunes to marry: perhaps his studies too. 'Tis certain he always had a kindness for her, visited her whenever in the country, in both her husbands' days, and gave her forty shillings upon a time, whenever it was of service to her. She is a little woman, but we may with ease discern that she has been very handsome."

The grammar school is the same now as it was when Sir

Isaac went to school there, with the exception of the renewal of the desks and benches. When he left for the University, it is said that his venerable teacher, Mr. Stokes, "placed his favorite pupil in the most conspicuous part of the school, and having with tears in his eyes made a speech in praise of his character and talents, held him up to the scholars as a proper object of their love and affection."

As we have quoted largely from Dr. Stukeley, it may be as well to say something about him. He was a native of Holbeach, and having resided first at Boston and then in London, he came to settle in Grantham in 1726. He practised there as a physician for two or three years, and then left medicine and took holy orders. He first held the living of All Saints, Stamford, then of Somerby near Grantham, and subsequently of St George's, Queen's Square, London. He died in 1765. He was the correspondent and friend of the most learned and respectable persons of his time. He was a member of the Royal Society at the time that Sir Isaac Newton was its President. He was intimate with the great philosopher, and says "April 15th, 1726, I passed the whole day with Sir Isaac alone at his lodgings, Orbels Buildings, Kensington, which was the last time I saw him." He was also acquainted with many persons who had known Sir Isaac for a long period. There is every reason therefore for believing that the account he gives of him is strictly accurate.

The following are some of the more important events which occurred while Sir Issac was at school at Grantham. The "sober, silent, thinking lad" no doubt pondered deeply on some of them, The execution of Penruddock, Grove, and Lucas for insurrection; the victories of Blake, the death of Oliver Cromwell, the dissolution of the Rump Parliament, and



GRAMMAR SCHOOL, GRANTHAM.

the restoration of the Stuarts. Harvey, the physiologist, died in 1657. Watches were first made for carrying in the pocket in 1658. Abraham Cowley, Edward Waller, Bishop Brian Walton, and Dr. Isaac Barrow, were in the height of their fame at that period.

CHAPTER III.

AT CAMBRIDGE: Student, Graduate, Fellow, and Professor.

At the age of eighteen and a half, Sir Isaac Newton became a member of the University of Cambridge, and went to reside there in 1661, the next year after the restoration. He entered himself at Trinity College, and, according to the books of that institution, was admitted Subsizar on the 5th of June, 1661, and matriculated Sizar on the 8th of July. "A Sizar at Cambridge," says Professor de Morgan, "was, in the original meaning of the word, a student whose poverty compelled him to maintain himself, in whole or part, by the performance of some duties which were originally of a menial character. By this institution a youth could live by the work of his hands while he pursued his studies. In our days there is but little distinction between the Sizars and those above them; except in college charges, none at all." The following extract from the Conclusion Book at Trinity College, affords us a peep at student life in those days, and tells us what formed one part at least of the duties of a Sizar. "January 16, 1660-1. Ordered also that no Bachelor, of what condition soever, nor any Undergraduate, come into the upper butteries, save only a Sizar that is sent *to see his tutor's quantum*, and then to stay no longer than

is requisite for that purpose, under penalty of sixpence for every time; but if any shall leap over the hatch, or strike a butler or his servant upon this account of being hindered to come into the butteries, he shall undergo the censure of the master and seniors." Such being the position of Sizars, the fact that Sir Isaac entered himself as one of them is a tolerably conclusive proof that his pecuniary resources must have been very limited; in short, he was poor. When he came up to Cambridge, Dr. Henry Ferne was master of Trinity, and fortunately for Sir Isaac, the learned Dr. Isaac Barrow had been elected Greek Professor in 1660, he was made Lucasian Professor in 1663, and Newton in course of time became his friend, colleague, and successor. Though Sir Isaac had been well grounded in his education at Grantham, and though the bent of his mind had led him to pick up a good deal of elementary and discursive information in mathematics and mechanics, yet it does not appear that he came up to Cambridge possessed of a greater amount of acquired knowledge in general, than usually falls to the lot of ordinary scholars at his age. Before he left Woolsthorpe, his uncle Ayscough had given him a copy of Sanderson's Logic, and this he had thoroughly mastered; and at Trinity, in order to prepare himself for lectures, he had studied Kepler's Optics so accurately, that the lecturer found he knew the subject as well as he did himself. At that period, Stourbridge (vulgo Stirbitch) fair, which is held annually about a mile from Cambridge, was one of the largest fairs in England; people came to it not only from all parts of the kingdom, but even from the Continent; regular streets of shops were laid out on the common, and a vast variety of articles were sold there which we should never meet with at any fair in the present day. It is not surprising then to find that Sir Isaac picked up a book on Judicial

Astrology on one of the book-stalls at the fair, and that he purchased it with a view of studying its contents. In the course of perusing it, he came to a figure of the heavens, which he found he could not understand without a previous knowledge of trigonometry, and he therefore purchased an English Euclid, which however he soon discarded as a "trifling book," on the ground that the truths enunciated in it were self-evident. He then applied himself to Descartes' Geometry, but at a later period of his life he expressed his regret that he had not paid greater attention to Euclid, and to the geometry of the ancients. In Descartes' work he soon found himself out of his depth, and for a time he laid it aside, returning to it, however, again and again at intervals, until he mastered the whole of it without assistance. The study of Descartes' Geometry seems to have introduced Newton to the higher mathematics, and in a note-book written by himself, there is, according to Sir David Brewster, the following entry under the date July 4, 1699. "By consulting an account of my expenses at Cambridge in the years 1663 and 1664, I find that in the year 1664, a little before Christmas, I being then Senior Sophister, bought Schooten's Miscellanies and Cartes' Geometry, (having read this Geometry and Oughtred's Clavis clean over half a year before) and borrowed Wallis' Works, and by consequence made these annotations out of Shooten and Wallis in winter between 1664 and 1665. At such time I found the method of Infinite Series; and in summer 1665, being forced from Cambridge by the plague, I computed the area of the Hyperbola, at Boothby, in Lincolnshire, to two and fifty figures by the same method. Is. Newton." Close and constant attention to these abstract studies, and long continued observations upon a comet in 1654, impaired his health to such a degree that, according to Mr.

Conduitt, he learnt from this illness "to go to bed betimes." On the 19th of February 1664, his attention was attracted, by two coronas, to the subject of circles round the moon, and he subsequently gave the theory of them in his Treatise on Optics. On April the 28th in the same year, there being then forty-four vacancies in the scholarships of Trinity College, Newton was elected to one of them. On this occasion he was examined in Euclid by Dr. Barrow, and that eminent scholar having expressed an indifferent opinion of his knowledge in that subject, he was induced to bestow more attention upon it than he had previously done. In January 1665, Newton took his Bachelor of Arts degree, along with twenty-five other members of Trinity, but as the order in which they were placed after examination has been provokingly omitted from the Grace Book at Trinity in that year, we are unable to ascertain the academical rank he held amongst the graduates.* The persons who examined him for his degree were the two Proctors for that year,—John Slader of Trinity and Benjamin Pulleyn of Trinity (Newton's tutor)†—together with John Eachard of Catherine Hall, and Thomas Gipps of Trinity.

The above is almost all that is known of the studies and pursuits of Newton at Cambridge up to the time of his taking his degree. He appears to have spent his vacations with his mother at Woolsthorpe and in visiting his friends, and he no doubt passed his time while at Cambridge in the same way that other students did. What undergraduate life at Cambridge in Newton's time was, we can form a very good idea of from the letters of John Strype, who subsequently became the celebrated annalist. Strype was a contemporary undergraduate with Newton though not of the same College, and like him he

* Edleston's Newton. † College Tutor.

was "a poor scholar;" their manner of life therefore would, no doubt, be very similar. The following is an extract from one of three letters from Strype to his mother, as published in one of the volumes of the Camden Society—the letter is dated Cambridge, 1662. "Do not wonder so much at our commons: they are more than many Colleges have. Trinity itself (where Herring and Davies are) which is the famousest College in the University, have but three-halfpence. We have roast meat, dinner and supper, throughout the weeke, and such meate as you know I not use to care for, and that is veal; but now I have learnt to eat it. Sometimes, nevertheless, we have boiled meat with pottage; and beef and mutton which I am glad of; which days we have fish at dinner, and tansy or pudding for supper. Our parts are then slender enough. But there is this remedy, we may retire into the butteries, and there take a half-penny loafe and butter or cheese; or else to the kitchen, and take there what the cook hath. But for my part, I am sure I never visited the kitchen yet, since I have been here, and the butteries but seldom after meals; unless for a ciza, that is for a farthingworth of small beer; so that less than a peny in beer doth serve me a whole day. Neverthelesse we sometimes have exceedings: then we have two or three dishes (but that is very rare): otherwise never but one, so that a cake and a cheese would be very welcome to me: and a neats tongue, or some such thing, if it would not require too much money. * * * * I am in a chamber that doth not at all please me. I have thoughts of one, which is a very handsome one, and one pair of stairs high, and that looketh into the master's garden. The price is but 20*s.* per annum, ten whereof a knight's son, and lately admitted into this College, doth pay, though he did not come till about Midsummer, so that I shall have to pay but

10*s.* a year besides my income, which may be about 40*s.* or thereabouts. * * * * At my first coming I laid alone; but since, my Tutor desired me to let a very clear lad lay with me, and an Alderman's son at Colchester, which I could not deny, being newly come: he hath laid with me now for almost a fortnight, and will do till he can provide himself with a chamber. * * * * We go twice a day to chapel; in the morning about seven, and in the evening about five. After we come from chapel in the morning, which is towards eight, we go to the butteries for our breakfast, which usually is five farthings; an half-penny loafe and butter and a cize of beer. But sometimes I go to an honest house near the College, and have a pint of milk boiled for my breakfast."

In another letter, dated 1664, the year before that in which Newton took his B. A. degree, Strype says, "We have hereabouts most intollerable robbing, never by report so much. I have heard within two or three days of six or seven robberies hereabouts committed; whereof two or three killed. No longer than last sabbath, a mile off, a man knocked on the head. Lately a scholar of Peter House had both his eares cut off, because he told the thieves, after he had delivered some money to them, that he would give them leave to inflict any punishment upon him if he had a farthing more: but they searching him, found, it seems, 20*s.* more: so they took him at his word, and inflicted the cheater's punishment upon him."

It is evident that the germs of those great discoveries which immortalized his name, existed in the mind of Newton even before he had taken his B. A. degree, and immediately after that event they began to manifest themselves more and more every year in a series of scientific papers and experiments, by which he gradually established his positions and unfolded

the result of his reflections. As these discoveries, however, were going on concurrently with each other, it will be better, in order to avoid confusion, to postpone further mention of them to subsequent chapters where they will be dealt with separately, and to proceed here with the ordinary life of Newton till he became Lucasian Professor.

In the summer of 1665, he was forced by the plague to leave Cambridge and to go into the country, and he remained there for more than a year, staying principally at Woolsthorpe, and paying short visits probably to other rural localities. Having returned to Cambridge, he was elected a Minor Fellow on October 1st, 1667. In order to obtain this honour, he would have to undergo an examination, and Mr. Edleston, in his Synoptical Life of Newton, gives the following memorandum relative to a fellowship examination which was drawn up by Lynnet, one of the Fellows who examined Newton for his Fellowship; though it was made out twenty-five years afterwards, the practice had probably undergone little change in the interval—it runs thus, "The fellowes on the 3rd day of their sitting must have a theme given them by the Master, w^{h} the chapel-clerk fetcheth for them: they sit 3 dayes being excused the 4th for their theme. They sit from 7 till 10, & from one to 4, each writing his name, his age, & his country: as doe the scholars, & also y^{e} Masters of Arts, w^{ch} papers are carried to y^{e} Master & Vice M$^{r.}$ the first morning so soon as all have written. Octob: 1st, by y^{e} tolling of y^{e} little bell at 8 in the morning y^{e} seniours are called & the day after at one o'clock to swear them y^{t} are chosen." Dr. Pearson was Master of Trinity at the time Newton was elected a Fellow, and Mr. Edleston informs us that there were nine fellowships vacant to be contended for, two of which had been caused by parties falling down

staircases; one of the said staircases being that in which Newton subsequently "kept." How many candidates offered themselves for the fellowship examination we have no means of ascertaining. Having been elected a Fellow, a set of chambers were, as usual, assigned to him, and those which he obtained were termed, in the college schedule of that date, the "Spirituall Chamber"; "a locality," Mr. Edleston says, "with respect to which the only conjecture that I have to offer (and it is not altogether free from objection) is, that the apartment so designated may have been the ground room next the Chapel, in the north east corner of the great court." In 1666 Newton had procured a glass prism, "to try therewith the phenomena of colours." In 1667, shortly after he had been elected a Minor Fellow, he again went into Lincolnshire, where he remained till February 1668, when he returned to Cambridge. On March the 16th, 1668, he was elected a Major Fellow, and on the 7th of July in that year he was created M.A. being twenty-third on a list of 148 signed by the Senior Proctor.

In 1669, Newton, being then twenty six years of age, wrote a letter of advice to his young friend Mr. Aston, who at the age of twenty seven was about to make a tour on the Continent. The letter, which we here transcribe, is a very interesting one, not only because it shows that even at that early age Newton had some knowledge of the human heart, but also because it proves, by the suggestions it contains as to mines and metals, that his mind must have been impressed with some belief in the doctrines of Alchemy.

Trinity College, Cambridge,
May, 1669.

Sir,

Since in your letter you give me so much liberty of spending my judgment about what may be to your advantage

in travelling, I shall do it more freely than perhaps otherwise would have been decent. First, then, I will lay down some general rules, most of which I believe you have considered already; but if any of them be new to you, they may excuse the rest; if none at all, yet is my punishment more in writing than yours in reading.

When you come into any fresh company, 1, Observe their humours. 2, Suit your own carriage thereto, by which insinuation you will make their converse more free and open. 3, Let your discours be more in querys and doubtings than peremptory assertions or disputings, it being the designe of travellers to learne, not to teach. Besides it will persuade your acquaintance that you have the greater esteem of them, and soe make them more ready to communicate what they know to you: whereas nothing sooner occasions disrespect and qvarrels than peremptorinesse. You will find little or no advantage in seeming wiser, or much more ignorant than your company. 4, Seldom discommend anything though never so bad, or doe it but moderately, lest you bee unexpectedly forced to an unhansom retraction. It is safer to commend anything more than it deserves, than to discommend a thing soe much as it deserves; for commendations meet not so often with oppositions, or, at least, are not usually soe ill resented by men that think otherwise, as discommendations; and you will insinuate into men's favour by nothing sooner than seeming to approve and commend what they like; but beware of doing it by a comparison. 5, If you be affronted, it is better in a forraine country to pass it by in silence, and with a jest, though with some dishonour, than to endeavour revenge; for, in the first case, your credit's ne'er the worse when you return into Engiand, or come into other company that have not heard of

the quarrell. But in the second case, you may beare the marks of the quarrell while you live, if you out-live it at all. But if you find yourself unavoidably engaged, 'tis best, I think, if you can command your passion and language, to keep them pretty eavenly at some certain moderate pitch, not much hightening them to exasparate your adversary or provoke his friends, nor letting them grow over much dejected to make him insult. In a word, if you can keep reason above passion, that and watchfulnesse will be your best defendants. To which purpose you may consider that, though such excuses as this—He provok't mee so much I could not forbear—may pass among friends, yet amongst strangers they are insignificant, and only argue a traveller's weaknesse.

To these I may add some general heads for inquirys or observations, such as at present I can think on. As 1, To observe the policy, wealth, and state affairs of nations, so far as a solitary stranger may conveniently doe. 2, Their impositions upon all sorts of people, trades, and commoditys, that are remarkable. 3, Their laws and customs, how far they differ from ours. 4, Their trades and arts, wherein they excell or come short of us in England. 5, Such fortifications as you shall meet with; their fashion, strength, and advantages for defence, and other such military affairs as are considerable. 6, The power and respect belonging to their degrees of nobility or magistracy. 7, It will not be time mispent to make a catalogue of the names and excellencys of those men that are most wise, learned, or esteemed in any nation. 8, Observe the mechanisme and manner of guiding ships. 9, Observe the products of nature in several places especially in mines, with the circumstances of mining and of extracting metals or minerals out of their ore, and of refining them; and if you

meet with any transmutations out of their own species into another, (as out of iron into copper, out of any metall into quicksilver, out of one salt into another, or into an insipid body, &c.) those above all will be worth your noting, being the most luciferous, and many times luciferous experiments too in philosophy. 10, The prices of diet and other things. 11, The staple commoditys of places.

These generals (such as at present I could think of,) if they will serve for nothing else, yet they may assist you in drawing up a modell to regulate your travels by.

As for particulars, those that follow are all that I can now think of, viz. Whether at Schemnitium, in Hungary, (where there are mines of gold, copper, iron, vitrioll, antimony, &c.) they change iron into copper by dissolving it in a vitriolate water, which they find in cavitys of rocks in the mines, and then melting the slimy solution in a strong fire, which in the cooling proves copper. The like is said to be done in other places, which I cannot now remember ; perhaps too it may be done in Italy. For about twenty or thirty years agone there was a certain vitrioll came from thence, (called Roman vitrioll) but of a nobler virtue than that which is now called by that name, which vitrioll is not now to be gotten, because perhaps, they make a greater gain by some such trick as turning iron into copper with it, than by selling it. 2, Whether in Hungary, Sclavonia, Bohemia, near the town Elia, or at the mountains of Bohemia near Silesia, there be rivers whose waters are impregnated with gold ; perhaps the gold being dissolved by some corrosive waters like *aqua regis*, and the solution carried along with the streams that run through the mines. And whether the practice of laying mercury in the rivers, till it be tinged with gold, and the straining the mercury through leather, that

the gold may stay behind, be a secret yet, or openly practised. 3, There is newly contrived in Holland, a mill to grind glasses plane withal, and I think polishing them too; perhaps it will be worth the while to see to it. 4, There is in Holland one Borry, who some years since was imprisoned by the Pope, to have extorted from him secrets (as I am told) of great worth, both as to medicine and profit, but he escaped into Holland, where they have granted him a guard. I think he usually goes cloathed in green. Pray enquire what you can of him, and whether his ingenuity be any profit to the Dutch. You may inform yourself whether the Dutch have any tricks to keep their ships from being all worm-eaten in their voyages to the Indies. Whether pendulum clocks do any service in finding out the longitude, &c,

I am very weary, and shall not stay to part with a long compliment, only I wish you a good journey and God be with you.

IS NEWTON.

Pray let us hear from you in your travells. I have given your two books to Dr. Arrowsmith.

On the 29th of October, 1669, Newton was appointed Lucasian Professor in the room of Dr. Barrow, who it is said resigned on purpose to make way for him. The Lucasian Professor, according to the statutes, must be a person "well skilled in mathematical science," and he gives an annual course of lectures, theoretical and experimental, on hydrostatics, pneumatics, optics, and the like. Between 1666 and 1669, Newton's studies were of a very miscellaneous character, and were doubtless interrupted by the re-appearance of the plague, and by his preparations for his fellowship examination. According to the note book of Newton which Sir David Brewster found among

the family papers, and which he quotes in his life of the philosopher, it appears that while he was absent from Cambridge on account of the plague, he purchased books, magnets, compasses, glass bubbles, drills, mandrels, gravers, hones, and hammers. In 1667, he bought Bacon's Miscellany, three prisms, and four ounces of putty. From a list of his payments too in the same note book, (which is in his own hand), it is clear that he was of a rather jovial turn, fond of a hand at cards, and very kind and liberal: "my Bachelor's account 17s. 6d." "At the tavern several other times £1." "Spent on my cousin Ayscough 12s. 6d." "On other acquaintance 10s." "Cloth, 2 yards, and buckles for a vest £2." "Lost at cards twice 15s." "At the tavern twice 3s. 6d." "Lent to Dr. Wickins £1 7s. 6d." "For oranges for my sister 4s. 2d." "Lent Dr. Wickins 11s." "Lent Wardell 3s., and his wife 2s." The note book also tells us that he went to London in August, 1668, and returned to Cambridge at the end of September.

Having thus installed Newton in the Lucasian chair, we will close this chapter with mentioning a few of the more noticeable events which occurred subsequently to his coming up to Cambridge as a student in 1661. The Act of Uniformity; the marriage of Charles the 2nd to Katharine of Portugal; the restoration of Dunkirk to the French for £400,000; two witches burned by order of Judge Hale; the great plague of London: the great fire of London: prosecutions of the Covenanters in Scotland; dismissal of Lord Clarendon; the peace of Aix-la-Chapelle; and the passing of the Habeas Corpus Act.

The Royal Society, of which Sir Isaac Newton was afterwards president, had its origin at first in Oxford; it was actually founded in London in 1660, and received its charter of incorporation on the 15th of July, 1662. In the same year hackney

coaches were first licensed. In 1661, Pepys says "I sent for a cup of tea (a Chinese drink) of which I had never drank before," and in 1664 the East India Company could only procure two pounds and two ounces of tea, which cost them forty shillings a pound. In 1663 the first saw mill in England was set up. Half-pence and farthings were first coined, and the first diving bell employed in 1665. The London Gazette was first published in 1666. Milton published his Paradise Lost in 1667. And in 1668 London was lighted by lanterns hung out by the citizens.

CHAPTER IV.

HIS DISCOVERIES.

The appointment of Sir Isaac Newton as Lucasian Professor in 1669 may be taken as the commencement of the period during which his wonderful discoveries in science were gradually perfected and given to the world, and we will therefore abandon for a time the plan on which we have hitherto proceeded in this slight sketch of the incidents of his life. Partly from an impatience of opposition, which was one of the leading characteristics of his mind—partly from an intense dislike to disputes and contentions—and partly, no doubt, from a desire to push his researches still further in the same direction, Newton was exceeding averse to make his discoveries public, and hence it came about that in almost every case they were not promulgated by him till a long time after he had originally verified them, and that discussions and disputes concerning each of them were going on concurrently for a number of years. Were we then to trace his life year by year, as we have hitherto done, it would only involve confusion and repetition, and we will therefore adopt the plan of giving a brief and separate account of the three principal discoveries which have immortalized his name, without attending strictly to the regular

chronological order of events. Other discoveries and suggestions Sir Isaac did indeed make, in addition to the three which we are about to describe, but they were of minor importance, and our limited space will not permit us to enter into them; nor in a brief sketch, which is intended principally for general and non-scientific readers, would it be appropriate to give a technical account of his discoveries, or of the experiments by which they were verified and illustrated. All we can do, and the best we can do, is to make our necessarily brief account of each subject as generally intelligible as we can.

The date which seems by common consent to be assigned to each of his three greatest discoveries is as follows:

1st, Fluxions, 1665: in this year on May 20th, he wrote a "Paper" on Fluxions, in which the notation of *points* is used; and on Nov. 13th in the same year, a "Discourse" on Fluxions, and their applications to tangents and curvature of curves.

2nd, The Unequal Refrangibility of Light, 1666, at the early part of the year.

3rd, The Theory of Universal Gravitation, 1666, later in the year, while at Woolsthorpe.

The above are not the dates, nor is it the order, in which the above discoveries were perfected and given to the world; but they are the dates which evidence assigns to the period when the mind of Newton was *first* occupied with each; and it will not be out of place here to call attention to the extraordinary fact, that, according to the established dates, given above, *the three grand discoveries which form the glory of his life, were conceived in his mind before the completion of his twenty-fourth year.*

Fluxions, now called the Differential Calculus. The invention of the fluxional analysis does more honour to the powers

of the human mind than perhaps any discovery of this or any preceding age; it opens to us a new world, and extends our knowledge as it were to infinity; it carries us beyond those bounds which seem prescribed to our mental powers, and leads to investigations and results which must otherwise have remained in impenetrable obscurity. The doctrine of fluxions or the differential calculus is a method of finding an infinitely small quantity, which, being taken infinite times, shall be equal to a given quantity; or, it is the arithmetic of the infinitely small differences of variable quantities. The foundation of this calculus is an infinitely small quantity, or an infinitesimal, which is a portion of a quantity incomparable to that quantity, or that is less than any assignable one, and therefore accounted as nothing; the error accruing by omitting it being less than any assignable one. Hence two quantities, only differing by an infinitesimal, are reputed equal. Thus in astronomy, the diameter of the earth is an infinitesimal, in respect of the distance of the fixed stars; and the same holds in abstract quantities. Professor de Morgan says "A curved figure differs from one the boundaries of which are consecutive straight lines, in that there is always a *gradual* change of direction going on at the boundaries of the former, while at those of the latter the changes are made only at certain places, and as it were in the lump. To apply the doctrines of mathematics to cases in which such perfectly gradual changes take place, had been always the greatest difficulty of the science. Archimedes had conquered it in a few cases; the predecessors of Newton had greatly extended what Archimedes had done, and had given what, to those who come after Newton and Leibnitz, would appear strong hints of an organized method of treating all cases. But the method itself, and an appropriate language for

expressing its forms of operation were still wanting." This method Newton discovered before the end of 1666, and as Sir David Brewster states "his analysis, consisting of the method of series and fluxions combined, was so universal as to apply to almost all kinds of problems. He had not only invented the method of fluxions in 1665, in which the motions or velocities of flowing quantities increase or decrease, but he had considered the increase and decrease of those motions or velocities themselves, to which he afterwards gave the name of *second fluxions*, using sometimes letters with one or two dots, to represent the first and second fluxions."

Had Newton made his great discovery public soon after he had mastered it, much better would it have been both for his reputation and for his happiness, for chiefly in consequence of his keeping it secret, from whatever motive, for many years, there sprung up a bitter, involved, and long protracted controversy as to whether he or Leibnitz was entitled to priority in the discovery. Leibnitz published his method in 1684, at a time when Newton had not given his analysis to the world, and hence Leibnitz and his friends subsequently insisted that he (Leibnitz) was the original inventor, while Newton and his supporters not content with clearly establishing his claim to what Leibnitz had endeavoured to appropriate to himself, went on to charge his opponent with having taken his method from Newton. The particulars of this controversy are far too extensive for such a publication as this, and we must therefore content ourselves with stating the result of it, according to Sir David Brewster "1st, That Newton was the first inventor of the *Method of Fluxions;* that the method was incomplete in its notation; and that the fundamental principle of it was not published to the world till 1687, twenty years after he had

invented it. 2nd, That Leibnitz communicated to Newton in 1677 his *Differential Calculus*, with a complete system of notation, and that he published it in 1684, three years before the publication of *Newton's Method*.

THE UNEQUAL REFRANGIBILITY OF LIGHT. At the period when Newton took his B. A. degree, it was the universal opinion that the perfection of refracting telescopes and microscopes depended on the degree of accuracy with which lenses of certain forms could be executed, and it was while carrying on some operations with a view to arrive at this accuracy, that Newton made his first experiments with the prism he had bought at Stourbridge fair. These experiments soon induced him to abandon what he calls his "glass works," in consequence, to use his own words, of his having found that "the perfection of telescopes was limited not so much for want of glasses truly figured according to the prescriptions of optick authors, (which all men have hitherto imagined), as because *light* itself is a hetero geneous mixture of differently refrangible rays, so that were a glass so exactly figured as to collect any one sort of rays into one point, it could not collect those also into the same point, which having the same incident upon the same medium, are apt to suffer a different refraction." Thus it was in the year 1666, when, as he himself informs us, he had bought "a triangular glass prism to try therewith the celebrated phenomena of colours," that Newton first hit upon his discovery of the decomposition of light. Resulting from his experiments with the prism, he was led to take "reflections" into consideration, but in consequence of interruptions produced by the plague, "it was more than two years before he proceeded." In 1668 he went on to carry into effect, on a small scale, his resolution to "take reflections into consideration," and thinking

"it best to proceed by degrees," he first made a small perspective to try whether his conjecture would hold good or not." This telescope that he now made was six inches long. The aperture of the large speculum something more than an inch, and as the eye-glass was a plano-convex lens, with a focal length of one-sixth or one-seventh of an inch, "it magnified about forty times in diameter," which he believed was more than any six-feet refracting telescope could do with distinctness. Such was his first reflecting telescope. He saw with it Jupiter distinctly round, with his four satellites, and also the horns or "moonlike phase of Venus." In consequence of further interruptions, he did not go on with the construction of reflectors till the autumn of 1671.

The discovery, then, which Newton made with regard to the properties and composition of light, amounts to this—that light, as it emanates from radiating bodies, such as the sun, for instance, is not a simple and homogeneous substance, but is composed of a number of rays endowed with unequal refrangibility, and possessing different colouring properties. The inequality of the refraction undergone by these rays in the same body, when they enter at the same angle of incidence, enabled him to separate them, and thus having them unmixed and pure, he was able to study their individual properties.

Thus far up to 1669: in that year having become Lucasian Professor, he proceeded to mature his first results, and was led to a variety of experiments by which he perfected and connected them. He composed a complete treatise, in which the fundamental properties of light were unfolded, established, and arranged, by means of experiment alone, without any hypothesis whatever.

In 1671, he made another reflecting telescope, which was

larger and better than the first. Towards the end of that year, at the request of some members of the Royal Society, it was sent up to that learned body, and presented to them by Sir Isaac. It was also shown to the King, and a description of it published in the Philosophical Transactions. The instrument may still be seen in the library of the Royal Society, where it is carefully preserved, and as it is in all essential parts like the small one he made at first, and as he is known to have made it entirely himself, the following inscription has been engraved on the stand, "The first Reflecting Telescope invented by Sir Isaac Newton, and made with his own hands." It will not be out of place to state here that, according to Mr. Edleston, the instrument now to be seen in Trinity College library, and shown to visitors as Newton's own telescope, belonged probably to Robert Smith, and that the inscription on it "Sir Isaac Newton's Telescope" means merely "a Newtonian telescope."

Although Newton, however, had read a course of lectures on optics in the University of Cambridge, in the years 1669-70, and 71, containing his principal discoveries regarding the different refrangibility of light, and towards the end of 1671 was preparing a series of twenty of them for the press, it is a singular fact that these discoveries were not formally communicated to the Royal Society till the following year, and that up to that time his reputation with that body was chiefly founded on his reflecting telescope. On the 23rd of Dec. 1671, he was proposed a Fellow of the Royal Society, on account of his telescope, by Dr. Seth Ward, Bishop of Salisbury, and on the intended honour having been communicated to him, he expressed his satisfaction with the event in the following words in a letter to the secretary, Mr. Oldenburg, "I am very sensible of the honour done me by the Bishop of Sarum in proposing me a candidate, and which I hope will be further conferred upon

me by my election into the society ; and if so, I shall endeavour to testify my gratitude by communicating what my poor and solitary endeavours can effect towards promoting your philosophical designs." What he means by the word "solitary" is not very clear. He was elected a Fellow on the 11th of January, 1672, on which day the society, with the view of securing his invention of the telescope from foreign piracy, agreed to transmit a drawing and account of it to Huygens. Thus encouraged, Newton lost no time in making communications to the Royal Society, and in a letter to their secretary, dated the 18th of January, 1672, he announces his optical discoveries in the following manner. "I desire that in your next letter you would inform me for what time the society continue their weekly meetings : because, if they continue them for any time, I am purposing them to be considered of and examined on account of a philosophical discovery, which induced me to the making of the said telescope, and which I doubt not but will prove much more grateful than the communication of that instrument, being, in my judgment, the oddest if not the most considerable detection which hath hitherto been made in the operations of nature.

This "oddest and most considerable detection" was the discovery of the different refrangibility of the rays of light. It was communicated in a letter to Oldenburg on the 6th of February, 1672, and excited great interest when read on the 8th of February to "that illustrious company." The "solemn thanks of the meeting were voted to its author for his very ingenious discourse ; and it was immediately printed in the 80th number of their Transactions, namely on the 19th of February, both for the purpose of having it well considered by philosophers, and for "securing the considerable notices thereof to the author against the arrogations of others." At the same

time, a committee, consisting of the Bishop of Salisbury, Mr. Boyle, and Dr. Hooke, was appointed to peruse and consider it, and to give in a report upon it to the society.

For the above account we are indebted chiefly to Sir David Brewster, who next proceeds, in his most valuable Life of the great philosopher, to describe other important discoveries which Newton made respecting colours and light. These our limits will not allow us to enter upon, and we only mention them as being the occasion of further proofs of that aversion to being opposed which Sir Isaac manifested in almost all the public transactions of his life. Most of these discoveries were either claimed, or attempted to be refuted, by Hooke, who, on the death of Oldenburg, became secretary to the Royal Society, and so greatly was Newton annoyed at Hooke's opposition, and so acutely did he feel the vexation at having to refute his adversary's positions and upset his claims, that he gave up his previous intention of printing his lectures on optics, with his treatise on series, and determined to commit himself no more with the public. "I intend," says he to Oldenburg, "to be no further solicitous about matters of philosophy: and therefore I hope you will not take it ill if you never find me doing any thing more of that kind; or rather that you will favour me in my determination, by preventing, so far as you conveniently can, any objections or other philosophical letters that may concern me." And in another letter to Oldenburg a year afterwards, he says "I see I have made myself a slave to philosophy; but if I get free of Mr. Linus's business, I will resolutely bid adieu to it eternally, excepting what I do for my private satisfaction, or leave to come out after me; for I see a man must either resolve to put out nothing new, or to become a slave to defend it."

THE THEORY OF UNIVERSAL GRAVITATION. It is beyond all doubt that Woolsthorpe has the honour of being the place where Newton first conceived the theory of universal gravitation, and the event occurred in 1666 when he was visiting his mother there, having been driven from Cambridge by the plague. We say "conceived" because it was not till eighteen years afterwards (1684) that he perfected his discovery. From the earliest times some indistinct conceptions are to be occasionally traced in different authors concerning the existence of the principle of gravitation, and Kepler, as early as the year 1600, had laid down the actual laws of the planetary motions; but it was reserved for Newton to establish by proof that which his predecessors had done little more than guess at, and to discover and demonstrate the *universality* of that gravitation on which the system of the world depends. To use Professor de Morgan's words, Newton "abolished the mysterious centre, to and from which motions were supposed to take place, and introduced universal gravitation, (the adjective, not the substantive, is his great discovery,) showing that if every *particle* attract every other *particle* inversely as the square of the distance, a whole sphere will attract as if its mass were collected at its centre."

Different opinions are entertained with regard to the truth of the well known story which represents Newton as having had his attention first directed to the subject of gravitation by the falling of an apple from a tree in his mother's garden. On one side—it was certainly mentioned to Voltaire by Catharine Barton who was Newton's niece, and who lived with him for many years; and it was also believed by Martin Folkes, the president of the Royal Society, who told it to Mr Green, the author of "The Philosophy of Expansive and Contracting Forces." On

the other side—it is not mentioned by Pemberton in his "View of Sir Isaac Newton's Philosophy," published in 1728, nor does Whiston, who received from Newton himself the history of his first ideas of gravitation say anything about it; and Professor de Morgan treats the whole story as a myth, and contends that the word "pomum" which is used in relating it, does not mean, in this instance, an apple, but "any round body," and that it might refer to the moon. In the absence, however, of decisive evidence on the point, we cannot see that there is anything very improbable in the story, and those of our readers who may have noticed the peculiar directness with which a large apple falls from a tree, when there is a still night, and the solid thump with which it comes to the ground, will not consider it, we think, at all unlikely that such an accident might have turned the attention of a thoughtful man to the laws of motion.

While Newton then was probably speculating on what had been conjectured by Kepler and others on the subject of gravitation, it occurred to him that as the same power by which an apple fell to the ground was not sensibly diminished at the greatest distance from the centre of the earth to which we can reach, neither at the summits of the loftiest spires, nor on the tops of the highest mountains, it might extend to the moon and retain her in her orbit in the same manner as it bends into a curve a stone or a cannon-ball when projected in a straight line from the surface of the earth. If the moon were thus kept in her orbit by gravitation to the earth, or, in other words, its attraction, it was equally probable, he thought, that the planets were kept in their orbits by gravitating towards the sun. To deduce from what Kepler had exhibited, says Professor de Morgan "of the laws of the planetary motions, that the force

must vary inversely as the square of the distance came within his power; but on trying the value of that force, as deduced from the moon's actual motion with what it should be as deduced from the force of gravitation at the earth, so great a difference was found as to make him throw the subject aside." The reason of his failure was that in his calculations he naturally employed the common estimate of the magnitude of the earth which at that period was in general use, and which indeed was the only one which then existed for him to adopt. It allowed only sixty English miles to a degree of latitude, instead of sixty-nine and a half, which is the true measurement. Hence his calculation did not come out correct, and in consequence he laid the subject altogether aside for nearly thirteen years. In 1679, in consequence of a correspondence with Hooke, then secretary of the Royal Society, he recurred to the subject, and having determined the curve described by a body under the action of a central force, he found that an attractive force emanating from a centre, and acting reciprocally to the squares of the distances, necessarily compels the body on which it acts to describe an ellipse. Newton himself distinctly states, in a letter to Halley in 1686, that Hooke's letters in 1679 were the cause of his "finding the method of determining the figures, which when I had tried in the ellipsis, I threw the calculations by, being upon other studies; and so it rested for about five years, till upon your request I sought for the papers." It is not certain at what time Newton became acquainted with the more accurate measurement of the earth executed by Picard in 1670. Picard's method of measuring a degree, and the precise result which he obtained, were communicated to the Royal Society early in 1672, and the results of his observations and calculations were published in the Philosophical

Transactions for 1675. It is almost a matter of certainty then, that Newton must have been acquainted with Picard's measurement long before 1679, and hence his resumption of the subject of gravitation in that year could not have been owing, as some suppose, to his then becoming acquainted for the first time with Picard's measurement, but merely to the fact that leisure then served for him to attend to Hooke's communications. As we have seen above, by Newton's letter to Halley, he threw the calculations aside in 1679, for about five years; this would bring us to 1684, and in that year Halley being on a visit to Newton at Cambridge, was informed by him that he had calculated the curve described by the planets, on the supposition that gravity diminished at the square of the distance, to be an ellipse. Newton, however, had mislaid his calculations at the time of Halley's visit, and in consequence of this, he worked them over again, and sent them to Halley in November 1684, through Mr. Paget, who was mathematical master at Christ's Hospital, and a friend of Newton. As Newton therefore informed Halley in August 1684, that he had then already calculated the curve to be an ellipse, and as he had then lost his papers, most probably on account of his having laid the subject aside in 1679 for "about five years," it is clear, we think, that he must have *applied* Picard's measurement as early as 1679, although it was not till 1684 that in working his missing calculations over again he "brought the demonstration of the laws of the celestial motions to perfection," and sent it through Paget to Halley in the November of that year. Whenever it was that he first applied Picard's measurement, it is said, that on seeing that the desired result was likely to come out, he became so nervous that he could not continue the calculation, but was obliged to intrust it to a friend; a statement, however,

which Sir David Brewster says has only tradition for its authority, and is not supported by what is known of Newton's character.

On receiving the demonstration from Newton in November 1684, Halley took another journey to Cambridge to confer with him about it, and on his return to London in December, he informed the Royal Society that "he had lately seen Mr. Newton at Cambridge, who had showed him a curious treatise, De Motu," which at Dr. Halley's desire he promised to send to the society to be entered on their register. Accordingly, Newton, having been reminded from time to time of his promise by Halley and Paget, at the request of the Royal Society, sent up his "notions about motion" to Mr. Aston, one of the secretaries, in February 1685, and the treatise containing them was forthwith duly registered. This treatise, *De Motu*, thus registered on the books of the Royal Society, was the germ of the Principia, and contained the more important truths which are demonstrated in the second and third sections of the first book of the Principia. Newton appears to have visited Lincolnshire for a few weeks in the early part of 1685, and on his return from thence in April, he applied himself diligently to the completion of his great work. In the spring of that year, he *determined the attractions of masses, and thus completed the demonstration of the law of universal gravitation;* and in the summer, he finished the second book of the Principia, the first book being the treatise *De Motu*, which he had already enlarged and completed. In April 1686, Halley announced to the society, that "Mr. Newton had an incomparable treatise on motion, almost ready for the press," and at the very next meeting of the society on the 28th of April, Dr. Vincent, (the husband of that Miss Storey for whom Newton had entertained an affection while at Grantham,)

" presented to the society a manuscript treatise, entitled *Philosophiæ Naturalis Principia Mathematica*, and dedicated to the society by Mr. Isaac Newton." The society accepted the treatise, sending a letter of thanks to its author, and ordered it to be printed, but strangely enough no provision appears to have been made for the expenses. It is certain, according to Rigaud, that " no pecuniary aid was extended to the Principia," and at length, Halley, who was a married man with a family, at " a considerable pecuniary risk, provided for the cost of the printing precisely at that period of his life when he could least afford it. Very shortly after the first book of the Principia had appeared, Hooke asserted that he had been in possession of the whole theory before Newton, and this conduct so disgusted the latter, that he proposed to omit the third book which contains the application to our system. By the intervention of Halley, however, Newton was prevailed on to complete the work as at first intended. Accordingly, the second book, having been made ready for the press in the autumn of 1686, was sent in in March 1687; the third book was produced and presented on the 3rd of April 1687, *and the whole work published about midsummer in that year.* It was dedicated to the Royal Society as flourishing under his august majesty James the 2nd, and a copy of it, with explanatory notes, was presented to the king by Halley. This great work as might have been expected, excited a warm interest in every part of Europe, and the first impression was very quickly sold. It demonstrated the laws of the universe, and established the principles of planetary motion, and to conclude with the words of Professor de Morgan, " no work on any branch of human knowledge was ever destined to effect so great a change, or to originate such important consequences."

CHAPTER V.

AT CAMBRIDGE—M. P. FOR THE UNIVERSITY—MASTER OF THE MINT—PRESIDENT OF THE ROYAL SOCIETY—KNIGHTED BY THE QUEEN—RESIDENCE IN LONDON—DEATH AND FUNERAL.

Having attempted in the previous chapter to give a description of Newton's principal discoveries, together with the dates at which they were perfected and given to the world, and the circumstances which accompanied their publication, we will now resume our former plan, and proceed to give a brief account of the most striking events of his life subsequent to 1669.

Having been appointed Lucasian Professor, Newton commenced an annual course of lectures, and his subjects while he held the office were optics, arithmetic and algebra, motion, and the system of the world. In 1670, he wrote some notes on Kinkhuysen's algebra at the request of Dr Barrow. And in the July of that year he had intended, during the Duke of Buckingham's installation as Chancellor of the University of Cambridge, to pay a visit to his friends in London, and to give Mr. Collins (a member of the Royal Society) "a verbal acknowledgment of his undeserved favours," but was prevented "by the sudden surprisal of a fit of sickness, which not long after, (God be thanked) I again recovered of." In the winter also of

that year, he had begun to "methodize his Discourse of Infinite Series, designing to illustrate it with problems," but he was "diverted from it by some business in the country," and he never completed it. During this period of his life, having been elected a Fellow of the Royal Society in 1672, he was chiefly engaged for several years with his discoveries on light, his improvements in telescopes, and his controversies with Pardies, Linus, Gascoigne, Lucas, Hooke, and Huygens. As he did not succeed in obtaining a Law Fellowship, (which was also a *lay* fellowship,) and as he refused to take holy orders, in consequence of his opinions not being in accordance with the Articles of the Church, he would have been compelled to vacate the fellowship he held, had not the king (Charles the 2nd) granted to him a patent dated April the 27th, 1675, permitting him to hold the Lucasian Professorship without taking holy orders. As Newton visited London in the early part of that year, it is probable that the royal patent was granted on his own application, supported, as it no doubt would be, by the Master and Fellows of Trinity. Not expecting perhaps at the early part of 1675 that he would be able to obtain the desired patent, and fearing that by the loss of his fellowship he might become straightened in his pecuniary means, he permitted Oldenburg to apply on his behalf to the Royal Society, to excuse him his weekly payment of one shilling; and by an entry in the books of the society it appears, that at a meeting of the council on January 28th, "it was agreed that he should be dispensed with as several others were." Whether he resumed his weekly payment on receiving the patent which enabled him to retain his fellowship, does not appear; but if he did not, it could not have been owing to poverty, as we find him in the very next year, 1676, subscribing £40 to the new library

at Trinity College, and subsequently in 1680 he lent to the College £100 on the same account.

From 1676 Newton seems to have been almost entirely occupied for several years with the discoveries described in our last chapter, with fresh scientific researches, and with his correspondence and controversies with learned men; and it was not till 1687 that the regular course of his life at Cambridge was disturbed by any extraordinary event. In that year, however, an incident occurred which drew him from his studious retreat, brought him on the theatre of public affairs, and by placing him in opposition to the Government of the day, enabled him to afford to the world a striking proof of his attachment to the principles of civil and religious liberty, of his devotion to the Protestant religion, and of his abhorrence of irresponsible power. James the 2nd, who had succeeded to the throne in 1685, on the death of Charles the 2nd, being desirous of re-establishing Catholicism in England, had begun to attack the rights and usuages of his Protestant subjects, and succeeding in having a Roman Catholic elected Dean of Christchurch, an office of the highest dignity at Oxford, he boasted to the Pope's Nuncio that "what he had done at Oxford would very soon be done at Cambridge." Accordingly, he issued a mandate in February, 1687, that Father Alban Francis, a Benedictine Monk, should be admitted a Master of Arts without taking the oaths of allegiance and supremacy. This mandate the University determined to resist, and, in consequence, the Vice Chancellor and deputies were summoned before the new High Commission at Westminster, on the 21st of April.

"The deputation," we quote from Sir David Brewster, "appointed by the Senate, consisted of Mr. Newton, Mr. Stanhope, the Chancellor of Ely, and other six deputies; but before

they went to London, they held a previous meeting in order to prepare their explanations and defence for the Court. "Some feeble or false men," as Burnet calls them, "had proposed to grant the degree on the condition that it should not be drawn into a precedent; and this contemptible proposal had recommended itself to the Chancellor of Ely." He accordingly produced a paper which he hoped the other deputies would sign, and in which this measure was presented in the most plausible form. A disposition to approve of it was manifested by the other deputies, but Newton seeing the character of the compromise, rose from his chair, took two or three turns round the room, and addressing the University bedel then standing at the fire, said to him, "This is giving up the question." "So it is" said the bedel, "Why didn't you go and speak to it.?" Upon which Newton went to the table, expressed his opinion, and proposed that the paper should be shown to Counsel. This suggestion was adopted. The paper was submitted "to Mr. Finch, afterwards solicitor to Lord Guernsey," and when he had given the same opinion as Newton, the Chancellor of Ely and the rest of the deputies concurred.

On the 21st of April the council chamber was filled with a large assemblage. Jeffreys presided at the board, and the Earl of Mulgrave, the sceptic and the hypocrite, sat there, a worthy companion of the judge. The deputation appeared as a matter of form before the commissioners, and were dismissed. On the 27th of April they gave in their plea. On the 7th of May it was discussed, and feebly defended by their incompetent Vice-Chancellor. The deputies maintained that in the late reign several royal mandates had been withdrawn, and that no degree had ever been conferred without the oaths of supremacy and obedience being taken. Jeffreys let loose his insolence

against the timid Vice-Chancellor, silenced the other deputies when they offered to speak, and without a hearing ordered them out of court. When recalled, the deputies were reprimanded, Pechel was deprived of his office as Vice-Chancellor, and of his emoluments as Master of Magdalen College; and the following words closed the address of Jeffreys:—"Therefore I shall say to you what the Scripture says, and rather because most of you are divines, 'Go your way, and sin no more, lest a worse thing come unto you.'"

Deprived of their Vice-Chancellor, the University choose for his successor John Balderston, Master of Emmanuel, "a man of much spirit," and under his guidance, the rights of religion and of the University were so ably defended, that the king thought proper to drop the affair. It was mainly therefore owing to the manly and opportune stand which Newton made against the proposition of the Chancellor of Ely, that Protestanism, thus nobly and unanimously defended, at the subsequent stages of the dispute was firmly established, and that the rights of the University were protected, and the Court taught a lesson by which it had not the wisdom to profit.*

The spirit and firmness which Newton displayed on this occasion, added to the reputation he had already gained as a philosopher, were no doubt the cause of his being chosen as one of the representatives of the University in parliament. This honour he received on the 15th of January, 1689, when he was elected by a majority of five, the numbers being—Sir R Sawyer 125, Mr. Newton 122, Mr. Finch 117. He thus became a member of the Convention Parliament which, having declared the throne vacant, conferred it on William and Mary, upon their giving their assent to the Declaration of Rights.

* Sir D. Brewster.

At the conclusion of this parliament, which lasted only a little more than a year, and was dissolved in February, 1690, Newton did not offer himself for re-election. During the short time he was then in parliament, he uniformly supported the principles of civil and religious liberty with firmness and moderation, and exhibited a capacity for business which could scarcely have been expected in a philosopher who had mixed so little with society. He does not seem ever to have taken any share in the debates, but though a silent, he was an active member, and ably fulfilled his duties both to his constituents and the public. He could not, however, have given a long attendance in parliament, for the books of his college show that he was not long absent from the University at that period; and, besides, he went into Lincolnshire for a time, in order to be present at the death-bed of his mother. To use the words of Sir D. Brewster, "The anxious and tender care with which his mother had watched over his helpless infancy, and reared to a vigorous manhood her only and sickly child, had produced on his part an attachment more than filial; while she had followed with a mother's pride the rising reputation of her son. In 1689, Benjamin Smith, the half brother of Newton, had been seized, while at Stamford, with a malignant fever. His mother, who had hastened to attend his sick bed, was taken ill with the same complaint, and Newton left his duties and his studies to watch at her couch. He sat up with her whole nights, administered with his own hands the necessary medicines, and prepared and dressed her blisters with all the dexterity of a practitioner. His skill, however, was unavailing. She sank under the disease, and her remains were carried to Colsterworth and deposited in the north aisle of the Church, where the family had generally been interred.

While Newton was in London attending parliament, he first became acquainted with John Locke, the philosopher, with whom he afterwards corresponded largely on theological subjects, and to whom he sent a letter containing an "Historical Account of two notable corruptions of Scripture." He also corresponded with Locke about Boyle's recipe for "multiplying gold" by combining a certain red earth with mercury.

At the close of 1692 and in the first two months of 1693, he wrote his four celebrated letters to Dr. Bentley, "containing some arguments in proof of a Deity."

In the years 1692 and 1693 Newton's bodily health was far from good, and arising from this circumstance, a report became current, first abroad and subsequently in England, "that he had to be taken care of by his friends and confined to his house," in consequence of his having "become deranged in his mind either from too great application to his studies, or from excessive grief at having lost by fire his chemical laboratory and some papers. We greatly regret that our limits will not permit us to give the evidence by which both Sir David Brewster and Mr. Edleston demonstrate, in the clearest possible manner, that there is not a word of truth in the report about Newton's insanity. If those of our readers who feel an interest in the point will consult either of the authors whom we have just named, they will find it established beyond all possible doubt that Newton's mental powers never were impaired at all, not even temporarily; and that the fire, which is supposed to have occasioned Newton's madness, occurred ten years before, in 1683, and even then was of no particular moment. As to the well known story about his dog having set fire to the written calculations of twenty years, and of his having administered to it no further rebuke than by saying "O Diamond, Diamond,

thou little knowest the mischief thou hast done" without adding a single stripe—it is considered by the best authors as a complete myth—a pure piece of fiction. It is generally brought forward as a proof of the gentleness of Newton's temper, and the scene is always laid in London. But there is no record whatever of any such fire having happened on his premises in London, or of his ever having kept a dog either in Cambridge or London; and Dr. Humphrey Newton, of Grantham, who was his assistant and amanuensis, says that "he never had any communion with dogs or cats."

Attempts appear to have been made by his friends on different occasions to obtain preferment for him, and at one time it was contemplated to appoint him to the Provostship of King's College, and at another time to the Mastership of the Charter House, but no progress was made in either case, and indeed Newton himself does not appear to have been anxious for either of those offices. At last, Charles Montague (afterwards Lord Halifax) who, while he was in residence at Trinity College as a Fellow Commoner, had formed an intimate friendship with Newton, became Chancellor of the Exchequer, and having formed a design to restore the coinage of the realm to its original value, gratified his personal feelings, and at the same time materially promoted the success of the project he had in hand, by entrusting the management of it to his scientific friend. Newton therefore was appointed Warden of the Royal Mint, and Mr. Montague announced the fact to him in a letter dated the 19th of March 1696. The value of this office to Newton was not less than £500 per annum, but in 1699 he was appointed Master of the Mint with a salary of £1500 per annum, and he held that office for the remainder of his life.

In consequence of his appointment to the Wardenship of the

Mint, and of his being obliged to enter upon the active duties of his office without delay, he left Cambridge and took up his residence in London. At first he appears to have had lodgings in the Tower, in order that he might be near the Mint; but in 1697 he took a house in Jermyn Street, near St. James' Church, and there he lived for thirteen years, till he went to Chelsea, where he lived a year. From the time of his appointment to the Mint, up to the year before his death, he attended with great diligence to all the duties of his office; and to him is chiefly owing the complete success of that great work, the recoinage of all the gold, silver, and copper money of the realm, which was commenced, under his superintendence, in 1696, and finished by him in 1699.

Having left Cambridge, he appointed Mr. Whiston in 1699 to be his deputy as Lucasian Professor, giving him "all the profits of the place;" and he also obtained the Professorship itself for the same gentleman when it became vacant by his own resignation of it in 1701: he resigned his Fellowship at Trinity in the same year.

On November the 26th, 1701, he was again elected a representative of the University in parliament; there was a contest on the occasion, and the numbers stood thus—the Right Hon. H. Boyle 180, Mr. Newton 161, Mr. Hammond 64. He retained his position as a member of the University in the first parliament of Queen Anne, but at the election for the second parliament, the University disgraced itself by throwing him out. He offered himself on whig principles, in conjunction with the Hon. F. Godolphin, but they were defeated by the tories, with the popular cry of "the Church in danger." Almost all the residents voted in favour of Newton, but they were overwhelmed by the out-voters, who were

against him. The election took place on May the 17th, 1705, and the numbers were—the Hon. A. Annesley 182, the Hon. D. Windsor 170, the Hon. F. Godolphin 162, Sir Isaac Newton 117.

Having been chosen a member of the council of the Royal Society in 1699, he received on November 30th, 1703, the high honour of being elected president of that illustrious society. He was annually re-elected during the remaining twenty-five years of his life; and he held the office for a longer time than any of his predecessors, and longer too than any of his successors, excepting Sir Joseph Banks.

Queen Anne, having become acquainted, through her Consort, Prince George of Denmark, with Newton's high merits, was resolved to take the first opportunity of showing her respect for his genius, and, accordingly, on going with her whole court to visit the University of Cambridge, from the Palace at Newmarket, where she was then residing, she conferred the honour of knighthood on him on the 16th of April, 1705. The business which caused him to be at Cambridge at that time was, no doubt, connected with the approaching election for the University. The honour was conferred on the Philosopher by the Queen herself, in the lodge of Trinity College. A sumptuous banquet was afterwards given to the royal visitor and suite in the hall of the college; and after the royal party had attended evening service in King's College chapel, they took leave of the University and returned to Newmarket.

On the 22nd of November, 1705, Sir Isaac made an affidavit before a master in chancery in proof of, and accompanying his pedigree: they are both of them given in full in "Turnor's Grantham."

In 1709 he entrusted to Roger Cotes,* of Trinity College, Cambridge, the preparation of the second edition of the Principia, which appeared in 1713. The correspondence between Newton and Cotes was published in 1850, by the Rev. J. Edleston, in a volume which displays great research, and contains a large mass of valuable information on many events in the life of Newton.

After Sir Isaac took up his residence in London, he lived in very handsome style and kept his carriage, with an establishment of three male and three female servants. In his own house he was hospitable and kind, and on proper occasions he gave splendid entertainments, though without ostentation or vanity.† No very striking event marked the latter part of his life, he passed his days much in the same manner from year to year, and his time was almost entirely occupied by his duties at the Mint, by his correspondence and intercourse with the leading men of the day, and in ably supporting his position as President of the Royal Society.

In May and June, 1714, he acted as one of the assessors of Moore, Bishop of Ely, at the trial of Dr. Bentley, for matters connected with his conduct as Master of Trinity; and about the same time he gave evidence before a committee of the House of Commons on the different methods of finding the longitude at sea. On the 16th of May, 1717, he presented his portrait to the Royal Society. In 1717, and in subsequent years, he drew up several reports for parliament on the state of the coin, Wood's halfpence, and similar subjects.

About the end of September, 1710, he removed from Chelsea

* He died at the age of 34. Newton said of him, "If Mr. Cotes had lived we might have known something."

† Sir D. Brewster.

to Martin Street, Leicester Square. It is the first house on the left hand, or east side of Martin Street, as you enter it from Leicester Square. It stands at the corner of Long's Court, next to a chapel, and is surmounted by a wooden erection, said to have been Newton's private observatory. The interior of the house is said to be in much the same state, with regard to the arrangement of the rooms, as it was in Sir Isaac's time, but the outside is altered. It is of good size, and formerly, perhaps, of some pretensions. A sketch of the interior of the observatory was given in the Illustrated London News for July, 1858. The house is still in good repair.

As to the works and opinions of Sir Isaac on chronology, we cannot do better than quote Professor de Morgan. "In 1714, at the accession of George the 1st, Newton became an intimate acquaintance of the Princess of Wales, (wife of George the 2nd,) who was also a correspondent of Leibnitz. Some observations made by the latter on the philosophy of Locke and Newton, brought on the celebrated correspondence between Leibnitz and Clarke. And at the same time an abstract of Newton's ideas on chronology, drawn up for the Princess and at her request communicated to Conti, got abroad and was printed at Paris; on which, in his own defence, he prepared his large work on the subject, published after his death. On this it is not necessary to speak: his ideas on chronology, founded on the assumption of an accuracy in the older Greek astronomers, which nobody now allows them, are rejected and obsolete. But the work does honour to his ingenuity and his scholarship, showing him to be not meanly versed in ancient learning."

In a brief sketch, like the present, it will not be expected that we should enter at any length into the question of Sir

Isaac's religious opinions. That he was a firm believer in christianity as a revelation from God, and in the divinity of our Saviour, is beyond all doubt; but whether he was a Trinitarian or an anti-Trinitarian, is a point of controversy, and we can here do no more than direct those who wish to see how the case really stands, to the two leading authorities on the question—Sir D. Brewster in the 2nd vol. of his "Life of Newton," page 313 *et seq*, and Professor de Morgan in his "Biography of Newton," in the Cabinet Portrait Gallery. From a very early period of his life, Sir Isaac devoted much time to the study of theology, and in his latter years it became one of his most habitual occupations. He published some "Observations upon the Prophecies of Holy Writ, particularly the Prophecies of Daniel and the Apocalypse of St. John,"—and he also wrote "An Historical Account of two notable corruptions of the Scriptures," (1 John, v. 7, and 1 Tim. iii. 16.) Besides these, he left at his death a large mass of papers upon theological subjects, which are still in existence, but *which have never been published.* They are in the possession of the Earl of Portsmouth, having come into that nobleman's family through Sir Isaac's grand niece, Miss Conduitt, who married Lord Lymington.

Nor shall we be expected, with our limited space, to state the evidence by which it can be most satisfactorily shown that there is not the slightest ground for certain insinuations which have been thrown out, with reference to the Earl of Halifax, (Charles Montague) unfavourable to the character of Miss Catharine Barton, who was the daughter of Robert Barton, Esq., of Brigstock, Northamptonshire, by his wife Hannah Smith, Newton's half-sister. This lady, being thus Sir Isaac's half-niece, kept her uncle's house, and resided with him for

twenty years—sixteen before, and four after her marriage to John Conduitt, Esq., M. P., of Cranbury, in Hampshire. The result of this marriage was an only daughter, Catharine Conduitt, who was married in 1740 to the Hon. John Wallop, afterwards Lord Viscount Lymington. She died in 1750, at the early age of thirty-two, leaving one daughter and four sons, from the eldest of whom the Portsmouth family is descended. With regard to Catharine Barton, afterwards Mrs. Conduitt, Mr. Conduitt himself distinctly says, "nobody ever lived with Sir Isaac but my wife, who was with him near twenty years before and after her marriage." The arguments pro and con with reference to the report about Miss Barton and the Earl of Halifax, will be found in "Notes and Queries," November 5th, 1853, and in Sir D. Brewster's "Life," vol. 2nd, page 270 *et seq.*

In July, 1722, when Sir Isaac had attained his eightieth year, the diseases of old age began to manifest themselves in an attack of the stone, from which he suffered severely. From this seizure the strength of his constitution enabled him to rally; and, assisted by Dr. Pemberton, he was occupied for about three years in superintending a third edition of his Principia, which made its appearance in 1726. His malady, however, ere long returned, and in January, 1725, he was again seized with an attack of the same complaint, accompanied on this occasion with violent cough and inflammation of the lungs. In consequence of this, he was prevailed upon to take up his residence at Kensington, and he appears to have had "lodgings in that agreeable part of Kensington called Orbell's, now Pitt's Buildings." (Maude's *Wensleydale*, 1772.) In February of the same year, he had an attack of the gout, but Mr. Conduitt says that in March his head was clearer and his memory stronger than it had been for some time. From this date his duties at

the Mint were undertaken for him by Mr. Conduitt, and he hardly ever went there himself for nearly a year before his death. Notwithstanding his great age and his imperfect health, he was able to attend the meetings of the Royal Society, and to receive with hospitality distinguished foreigners who were introduced to him. One of the last duties he discharged with the pen was that of obtaining for Colin Maclaurin the situation of assistant and successor to Mr. James Gregory, Professor of Mathematics in the University of Edinburgh; and in his letter to the Lord Provost on the subject, he says, "I am ready (if you please to give me leave,) to contribute twenty pounds per annum towards a provision for him, till Mr. Gregory's place become void, if I live so long, and I will pay it to his order in London."

We now arrive at the closing scenes of his life, and will describe them in the words of Mr. Conduitt, who was with him at the time.—"On Tuesday, the last day of February, 1727, he came to town in order to go to a meeting at the Royal Society. The next day I was with him and thought I had not seen him better of many years, and he was sensible of it himself, and told me smiling, that he had slept the Sunday before from eleven at night to eight in the morning without waking; but his great fatigue in going to the society, and making and receiving visits, brought his old complaint violently upon him. He returned to Kensington on the Saturday following. As soon as I heard of his illness, I carried Dr. Mead and Mr. Cheselden to him, who immediately said it was the stone in the bladder, and gave no hopes of his recovery. The stone was probably moved from the place where it lay quiet, by the great motion and fatigue of his last journey to London, from which time he had violent fits of pain with very short inter-

missions: and though the drops of sweat ran down from his face with anguish, he never complained or cried out, or showed the least signs of peevishness or impatience, and during the short intervals from that violent torture, would smile and talk with his usual cheerfulness. On Wednesday, the 15th of March, he seemed a little better, and we conceived some hopes of his recovery, but without grounds. On Saturday morning, the 18th, he read the newspapers, and held a pretty long discourse with Dr. Mead, and had all his senses perfect; but that evening at six, and all Sunday, he was insensible, and died on Monday, the 20th of March, between one and two o'clock in the morning. He seemed to have *stamina vitæ* (except the accidental disorder of the stone) to have carried him to a much longer age. To the last he had all his senses and faculties strong, vigorous, and lively, and he continued writing and studying for many hours every day, to the time of his last illness."

Thus died that great philosopher, Sir Isaac Newton, in the eighty-fifth year of his age, at his lodgings in Orbell's Buildings, Kensington, on the 20th of March, 1727.

Before his body was interred, the celebrated sculptor Roubilliac took a plaster cast of his face, and from this cast the features of almost all the statues and busts of him have been taken. One copy of the mask is in the library of the Royal Society, and another in the library of Trinity College, Cambridge. There is an engraving of it in Brewster's "Life."

The body of Sir Isaac was removed from Kensington to London, where it lay in state in the Jerusalem Chamber, and on the 28th of March it was thence conveyed to Westminster Abbey, where it was buried, near the entrance into the choir, on the left hand. The pall was supported by the Lord High

Chancellor, the Dukes of Montrose and Roxburghe, and the Earls of Pembroke, Sussex, and Macclesfield, who were Fellows of the Royal Society. The Honourable Sir Michael Newton, Knight of the Bath, was chief mourner, and was followed by some other relations, and several eminent persons, who were intimately acquainted with the deceased. The funeral service was performed by the Bishop of Rochester, attended by the Prebends and choir.

The relations of Sir Isaac who inherited his personal estate agreed to devote £500 to the erection of a monument to his memory, and the Dean and Chapter of Westminster appropriated for it a place in the most conspicuous part of the Abbey, which had often been refused to the greatest of our nobility. This monument was erected in 1731, and is still there in good preservation. It bears an epitaph in Latin, of which the following is a literal translation.—

Here lies
SIR ISAAC NEWTON, KNIGHT,
Who, by a vigour of mind almost supernatural,
First demonstrated
The Motions and Figures of the Planets,
The Paths of the Comets, and the Tides of the Ocean.
He diligently investigated
The different refrangibilities of the Rays of Light,
And the properties of the Colours to which they give rise.
An Assiduous, Sagacious, and Faithful Interpreter
of Nature, Antiquity, and the Holy Scriptures;
He asserted in his Philosophy the Majesty of God,
And exhibited in his Conduct the simplicity of the Gospel.
Let Mortals rejoice
That there has existed such and so great
AN ORNAMENT OF THE HUMAN RACE.
Born 25th Dec. 1642. Died 20th March, 1727.

CHAPTER VI.

MISCELLANEA.

Sir Isaac Newton left no will; he refused to make one because he said he considered a legacy no gift. A little before his death, he gave away an estate at Baydon, in Wiltshire, to the sons and daughter of a brother of Mrs. Conduitt, who, in consequence of their father dying before Sir Isaac, had no share in the personal estate. He also gave an estate of the same value, which he bought at Kensington, to Catharine, the only daughter of Mr. Conduitt, and this estate was sold by the Earl of Portsmouth, to whom it descended. The family estates at Woolsthorpe and Sewstern went to John Newton, the heir-at-law, whose great grandfather was Sir Isaac's uncle. This gentleman sold them in 1732 to Edmund Turnor, Esq., of Stoke Rochford.

The personal estate of Sir Isaac, which was worth about £32,000, was divided among his four nephews and four nieces by the half blood, the grand-children of his mother, by the Rev. Mr. Smith, of North Witham. As we have previously seen, Sir Isaac had no full brother or sister, but by her second husband, Mr. Smith, his mother had three children, Benjamin, Mary, and Hannah; and the persons whom we have just men-

tioned as having inherited Sir Isaac's personal estate, were the three children of his half-brother, Benjamin Smith; the three children of his half-sister Mary, who married Mr. Thos. Pilkington, of Belton, Rutland; and the two children of his half-sister Hannah, who married Mr. Barton, of Brigstock, Northampton. These were the nephews and nieces who subscribed £500 for the monument in Westminster Abbey. In the course of his life, Sir Isaac was very kind to all the Ayscoughs. To one he gave £800, to another £200, and to a third £100, and many other sums; and other engagements he also entered into for them. He was the ready assistant of all who were in any way related to him.

Sir Isaac was succeeded in his office as Master of the Mint, by his nephew by marriage, John Conduitt, Esq.

According to Sir David Brewster, "in personal appearance Sir Isaac Newton was not above the middle size, and in the latter part of his life was inclined to be corpulent." According to Mr. Conduitt, "he had a very lively and piercing eye, a comely and gracious aspect, with a fine head of hair as white as silver, without any baldness, and when his peruke was off was a venerable sight." Bishop Atterbury asserts, on the other hand, that the lively and piercing eye did not belong to Sir Isaac during the last twenty years of his life. "Indeed," says he, "in the whole air of his face and make there was nothing of that penetrating sagacity which appears in his compositions. He had something rather languid in his look and manner, which did not raise any great expectation in those who did not know him." This opinion of Bishop Atterbury is confirmed by an observation of Mr. Thomas Hearne, who says, "that Sir Isaac was a man of no very promising aspect. He was a short well-set man. He was full of thought and spoke very little in

company, so that his conversation was not agreeable. When he rode in his coach, one arm would be out of his coach on one side, and the other on the other." Sir Isaac never wore spectacles, and never lost more than one tooth to the day of his death."

Notwithstanding his extraordinary abilities, he was extremely modest and unassuming. To one who had asked him on some occasion by what means he had arrived at his discoveries, he replied " By always thinking unto them ;" and at another time he thus expressed his method of proceeding, " I keep the subject constantly before me, and wait till the first dawnings open slowly by little and little into the full and clear light." Again, in a letter to Dr. Bentley he says, " If I have done the public any service in this way, it is due to nothing but industry and patient thought." And a short time before his death he uttered this memorable sentiment, " I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the sea shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me."

"He was generous and charitable" says Mr. Conduitt, "without bounds : he used to say that they who gave away nothing till they died, never gave ; which perhaps was one reason why he did not make a will. I believe no man of his circumstances ever gave away so much during his life-time in alms, in encouraging ingenuity and learning, and to his relations, nor upon all occasions showed a greater contempt of his own money, or a more scrupulous frugality of that which belonged to the public, or to any society he was entrusted for. He refused pensions and additional employments that were offered to him, and was highly honored and respected in all reigns, and under all administrations, even by those he opposed, for in every

station he showed an inflexible attachment to the cause of liberty, and our present happy establishment. * * * * He had so humble an opinion of himself that he had no relish of the applause which was so deservedly paid him; and he was so little vain and desirous of glory from any of his works, that he, as it is well known, would have let others run away with the glory of those inventions which have done so much honour to human nature, if his friends and countrymen had not been more jealous than he of his and their glory. He was exceedingly courteous and affable even to the lowest, and never despised any man for want of capacity, but always expressed freely his resentment against any immorality or impiety. He not only showed a great and constant regard to religion in general, as well by an exemplary course of life as in all his writings, but was also a firm believer of revealed religion, which appears by the many papers he has left on that subject." He cherished the great principles of religious toleration, and never scrupled to express his abhorrence of persecution even in its mildest form. When Vigani told him "a loose story about a nun" he gave up his acquaintance, and when Dr. Halley ventured to say anything disrespectful to religion, he invariably checked him with the remark, "I have studied these things,—you have not."

"He considered," says Sir David Brewster, "that cruelty to beasts was a violation of christian morality, and such was his tenderness for the lower creation, that he could not tolerate the sports of hunting or shooting animals. When Mr. Conduitt was one day speaking favorably of one of Sir Isaac's nephews, he urged it as an objection against him, "that he loved killing of birds."

When he had been imposed upon with regard to the purchase of an estate, and was told that he might vacate the bargain in

equity, he replied that he would not for the sake of two thousand pounds go into Westminster Hall to tell that he had been made a fool of."

The great defect in Sir Isaac's character was his innate dislike to opposition, and a dread of disputation. Most of the troubles of his life were owing to this; since a fear of having to defend them, induced him to conceal his discoveries for many years after he had made them, and then they were claimed by others, and he was consequently forced, after all, into the very controversies which he was so nervously anxious to avoid.

In 1716, Leibnitz, wishing to show the superiority of his calculus over Newton's method of fluxions, sent, in a letter to the Abbé Conti, the enunciation of a certain problem, in which it was required to discover a curve such as should cut at right angles an infinity of curves of a given nature, but all expressible by the same equation: "he wished," he said, "to feel the pulse of the English analysts." Of course the question was a very difficult one. It is said that Newton received the problem at four in the afternoon, as he was returning from the Mint, and that, though extremely fatigued with business, he finished the solution before retiring to rest.

In the year 1683, Newton requested Mr. Walker, who was then schoolmaster at Grantham, to engage Mr. Humphrey Newton, of that town, as an assistant or amanuensis. Mr. Newton willingly accepted the offer, and the following extracts from two letters of his to Mr. Conduitt dated Grantham, 1728, which are given by Sir D. Brewster, are exceedingly interesting, as describing accurately Sir Isaac's manner of life at the time he was engaged in preparing his Principia.—"His carriage was then very meek, sedate, and humble, never seemingly angry, of profound thought; his countenance mild, pleasant, and comely.

I cannot say that I ever saw him laugh but once, which was at that passage which Dr. Stukeley mentioned in his letter to your honour, (Mr. Conduitt) which put me in mind of the Ephesian philosopher, who laughed only once in his lifetime to see an ass eating thistles when plenty of grass was by. * * * * So intent, so serious upon his studies, that he ate very sparingly; nay, oftimes he has forgot to eat at all, so that going into his chamber, I have found his mess untouched, of which when I have reminded him, he would reply, "Have I," and then making to the table, would eat a bit or two standing, for I cannot say I ever saw him sit at table by himself. * * * He very rarely went to bed till two or three of the clock, sometimes not till five or six, lying about four or five hours, especially at spring and fall of the leaf. * * * * I cannot say I ever saw him drink either wine, ale, or beer, excepting at meals, and then but very sparingly. He very rarely went to dine in the hall, except on some public days, and then, if he has not been minded, would go very carelessly, with shoes down at heels, stockings untied, surplice on, and head scarcely combed. * * * * Near his elaboratory was his garden, which was kept in order by a gardener. I scarcely ever saw him do anything, as pruning, &c., at it himself. * * * * His brick furnaces *pro re nata* he made and altered himself, without troubling a bricklayer."

The passage alluded to in Dr. Stukeley's letter was the following: When Sir Isaac once laughed, "'twas upon occasion of asking a friend to whom he had lent Euclid to read, what progress he had made in that author and how he liked him? He answered by desiring to know what use and benefit in life that study would be to him. Upon which Sir Isaac was very merry."

It is interesting to know that the rooms which Sir Isaac

occupied in Trinity College, from 1682 to his leaving Cambridge in 1696, and which were the scene of his labours on the Principia, as described in the foregoing extracts from Humphrey Newton's letters, were in the north east corner of the great court. They were on the first floor of the staircase, on the right hand, or to the north of the great gateway or principal entrance to the College, the outward door fronting the staircase, the rooms being to the right. His laboratory, as Humphrey Newton tells us, was "on the left end of the garden, near the east end of the chapel," and his telescope, which according to the same authority, was five feet long, was placed at the head of the stairs going down into the garden looking to the east. These rooms, between the great gateway and the chapel, have had an entirely new front put to them within the last two years. You face them as you come out of the south branch of All Saints' passage : the space in front within the iron railing was Newton's garden. While Sir Isaac was Lucasian Professor, he took two Fellow-Commoners as pupils, one was Mr. George Markham, son of Sir Robert Markham, of Sedgebrook, near Grantham, and the other Mr. Robert Sacheverell, whose mother was daughter to the second Sir John Newton.

Loggan's plates, representing the Colleges as they were at the time of Newton's residence at Cambridge, can be seen in the University library, and among the many valuable notes to Mr. Edleston's Synoptical View of Newton's Life, we find this : "The following chronological notices, in conjunction with Loggan's plates, will enable the academical reader to picture to himself the College as it was when Newton walked to and fro within its courts :—

1670—1.—Gerrard's Hostle rebuilt at the expense of Bishop Hacket, and thence called Bishop's Hostle.

1670. — February.—Foundation of the new library dug.
1678. — Rooms over eight arches next the library in the north cloister finished; those next the library being built out of the subscriptions for the library, those next to them to the east, at the expense of Sir Thomas Sclater.
1681—2.—Rooms over eight arches next the library in the south cloister built; those adjoining the library out of the library subscriptions, the others at the expense of Dr. Humfrey Babington.
1681. — May 7.—Four statues on the top of the library, by Cibber, for which he received £80.
1685. — February.—New library ceiled.
1686. — Library floor laid down.
1687—8.—Library paved.
1694. — Ruinous part of King's Hostle pulled down.
1695. — Books removed from the old library to the new."

The chair which Sir Isaac used is now the property of J. Hogarth Esq., of London, and that gentleman in a letter to a friend dated September, 1858, gives the following amusing account of the manner in which he became possessed of it.—" Newton's chair was bought by me somewhere about the year 1827, at the sale of effects of a gentleman deceased in Charlotte Street, Fitzroy Square, who was curious in collecting chairs of eminent men, but from some cause he left no description of them, and they were sold with his other property merely as furniture, and described only as an arm chair, a ditto, &c. I was at this time occupied by Sir Thomas Lawrence in the formation and charge of his valuable collection of drawings by the Old Masters, and by some means which I was unacquainted with, he obtained information that the chair in which Sir Joshua Reynolds used to place his sitters was to be sold. I went to buy it.

There was nothing in the appearance of the chair to lead to the conclusion that it would sell for more than its appa-

rent value, and when it reached the sum of two guineas the furniture dealers, mostly Jews, began to thump the seat in search of some concealment; but when it reached 5, 6, 7, 8, and 10 guineas they were perfectly frantic, tried to unscrew the legs, asked each other if they had examined the article, and very unceremoniously asked, "What the devil does it mean? What is in the chair?" It was ultimately knocked down to me for eleven guineas; but so much confusion and excitement was caused by the supposition that the chair contained some secret treasure, every body present trying to see it, that the following lot described as a "ditto" did not get a bid, and another lot was added to it, when one of the Jews impudently touched me on the back and said, "Will you give me the same for that," to which I replied "No, I will leave it to you, I would not give more for it than your price, half-a-crown." In the absence of any other offer the auctioneer took my bid and knocked the lot down to me, much at the moment to my vexation, until glancing at the chair I saw it was not so bad as I thought it was by the absence of all bidding, and I paid for it leaving the other lot to be settled for in the name of Sir Thomas Lawrence.

"About two or three years after this, I. T. Smith, the author of "Nollekens and his Times," was at my house. I then learnt that it was he who drew Lawrence's attention to Sir Joshua's chair, and, he added, "but there was a much more curious chair in the sale which I intended to buy, but unfortunately as unexpectedly I could not get away in time from the museum; it was bought by Money, and I wish I could find out who Money is." He talked so much about the chair, and the part of the sale in which it was placed, that all of a sudden my purchase came into my mind, and without saying anything to him, I led him to my bedroom where the chair was, and the instant he saw it he started

back almost breathless, exclaiming, 'That's the chair, that is the chair of the great Sir Isaac Newton.' He came several times to induce me to sell it to him, but I refused him, and the chair has ever since remained in my possession, as a very comfortable bed-room chair."

Sir Isaac never was married. In his youth, however, as we have already seen, he was in love with a Miss Storey, whom he met at Mr. Clark's, of Grantham, in whose house he lodged; and at the mature age of sixty he is supposed to have written a love letter, containing an offer of marriage, to a Lady Norris, the widow of Sir William Norris, of Speke, near Liverpool. The letter is given by Sir David Brewster in his "Life," and the wording of it is such, that it is just possible that it may have been written by Sir Isaac on behalf of some bashful friend. Sir David Brewster, however, is of opinion, and we think rightly so, that Sir Isaac wrote it on his own account.

Mr. Edleston gives the following letter from Newton to Lord Townshend, which is interesting, as showing his opinion on capital punishments.—

My Lord,

I know nothing of Edmund Metcalf, convicted at Derby assizes of counterfeiting the coyne, but since he is very evidently convicted, I am humbly of opinion, that it's better to let him suffer than to venture his going on to counterfeit the coin, and teach others to do so, until he can be convicted again, for these people very seldom leave off. And it's difficult to

* The chair was sent to Grantham by Mr. Hogarth to be used at the Inauguration of the Statue, and Lord Brougham occupied it on the platform. Time has evidently had a deterioating effect upon its appearance.

detect them. I say this with most humble sumbmission to his majesty's pleasure, and remain,

My Lord,

Your Lordship's most humble and obedient Servant,

IS. NEWTON.

Mint Office, Aug. 25th, 1724.

Lord Townshend, (Secretary of State.)

Mr. Edleston also gives a letter from Sir Isaac Newton to Sir John Newton, in 1707, soliciting that an undertaker who has "married a near kinswoman of mine," may be employed in the funeral of a Mr Cook, lately deceased.

Stukeley says, that "when Newton had friends to entertain, if he went into his study to fetch a bottle of wine, there was danger of his forgetting them." When he was going home to Colsterworth from Grantham, he once led his horse up Spittlegate Hill, at the town-end. When he designed to remount, his horse had slipped the bridle, and gone away without his perceiving it, and he had only the bridle in his hand all the while."

It is said that a very intimate friend of Sir Isaac's happened to call one day at his house, and was introduced into the room where Sir Isaac generally dined, and where a boiled chicken had been sometime waiting for him under a cover, agreeable to his own direction, but he was then too busily engaged in his study to attend to anything of that kind. The gentleman not having himself dined. and finding, after some turns, that Sir Isaac did not come, sat down himself to the chicken and and completely picked it, putting the cover over the bones and giving the servant directions to prepare another. After a while Sir Isaac comes down from his study, and telling his friend he was both weary and hungry, takes off the cover under

which he supposed the chicken was, but found there little else besides bones, upon which he immediately concluded within himself that he had already dined, and that it had escaped his memory. "Well" said he, looking at his friend and smiling, "in truth I had utterly forgot that I had dined before."

In 1724, in a letter to Mr. Mason, then Rector of Colsterworth, he notified his intention of subscribing £12 towards erecting a gallery in the parish church there; and in 1725, in another letter to Mr. Mason, he says that he is very glad to hear that the gallery is finished, and requests him to apply any surplus there may be "to the use of the young people of the parish that are learning to sing psalms." In 1726, he sent £3 more for repairing the floor of the church.

According to Sir D. Brewster, a very remarkable proof of Sir Isaac's integrity is given in the following interesting extract of a letter from the Rev. Dr. Derham to Mr. Conduitt:—"The last thing, sir, that I shall trouble you with shall be a passage relative to the coinage of the copper money, some years ago, which pleased me much, in setting forth the integrity of my friend Sir Isaac. The occasion of our discourse was the great inconveniences which many underwent by the delay of the coinage of this sort of money. The occasion of which delay Sir Isaac told me was from the numerous petitions that were presented to them, in most of which some person or other of quality was concerned. Amongst others, he told me that an agent of one had made him an offer of above £6000, which Sir Isaac refusing, on account of its being a bribe, the agent said he saw no dishonesty in the acceptance of the offer, and that Sir Isaac understood not his own interest. To which Sir Isaac replied, that he knew well enough what was his duty, and that no bribes should corrupt him. The agent then told him that he came from a

great dutchesse, and pleaded her quality and interest. To which Sir Isaac roughly answered, "I desire you tell the lady, that if she was here herself, and had made me this offer, I would have desired her to go out of my house, and so I desire you, or you shall be turned out." Afterwards he learned who the dutchesse was."

THE INAUGURAL ORATION

DELIVERED BY

LORD BROUGHAM,

AT GRANTHAM,

WITH HIS LORDSHIP'S NOTES.

To record the names, and preserve the memory of those whose great achievements in science, in arts, or in arms have conferred benefits and lustre upon our kind, has in all ages been regarded as a duty and felt as a gratification by wise and reflecting men. The desire of inspiring an ambition to emulate such examples generally mingles itself with these sentiments; but they cease not to operate even in the rare instances of transcendent merit, where matchless genius excludes all possibility of imitation, and nothing remains but wonder in those who contemplate its triumphs at a distance that forbids all attempts to approach. We are this day assembled to commemorate him of whom the consent of nations has declared that he is chargeable with nothing like a follower's exaggeration or local partiality, who pronounces the name of NEWTON as that of the greatest genius ever bestowed by the bounty of providence for instructing mankind on the frame of the universe, and the laws by which it is governed.

> Qui genus humanum ingenio superavit, et omnes
> Restinxit; stellas exortus uti ætherius sol.—(*Lucr.*)

In genius who surpassed mankind as far
As does the mid-day sun, the midnight star.—*(Dryden)*

But though scaling these lofty heights be hopeless, yet is there some use and much gratification in contemplating by what steps he ascended. Tracing his course of action may help others to gain the lower eminences lying within their reach; while admiration excited and curiosity satisfied are frames of mind both wholesome and pleasing. Nothing new, it is true, can be given in narrative, hardly anything in reflection, less still perhaps in comment or illustration; but it is well to assemble in one view various parts of the vast subject, with the surrounding circumstances whether accidental or instrinsic, and to mark in passing the misconceptions raised by individual ignorance, or national prejudice, which the historian of science occasionally finds crossing his path.

The remark is common and is obvious, that the genius of Newton did not manifest itself at a very early age. His faculties were not, like those of some great and many ordinary individuals, precociously developed. Among the former, Clairaut stands pre-eminent, who, at nineteen years of age, presented to the Royal Academy a memoir of great originality upon a difficult subject in the higher geometry; and at eighteen, published his great work on curves of double curvature, composed during the two preceding years. Pascal, too, at sixteen, wrote an excellent treatise on conic sections. That Newton cannot be ranked in this respect with those extraordinary persons, is owing to the accidents which prevented him from entering upon mathematical study before his eighteenth year; and then a much greater marvel was wrought than even the Clairauts and the Pascals displayed. His earliest history is involved in some obscurity; and the most celebrated of men has in this particular been

compared to the most celebrated of rivers,* as if the course of both in its feebler state had been concealed from mortal eyes. We have it, however, well ascertained that within four years, between the age of 18 and 22, he had begun to study mathematical science, and had taken his place among its greatest masters; learnt for the first time the elements of geometry and analysis, and discovered a calculus which entirely changed the face of the science, effecting a complete revolution in that and in every branch of philosophy connected with it. Before 1661 he had not read Euclid; in 1665 he had committed to writing the method of fluxions. At 25 years of age he had discovered the law of gravitation, and laid the foundations of celestial dynamics, the science created by him. Before ten years had elapsed, he added to his discoveries that of the fundamental properties of light.—So brilliant a course of discovery, in so short a time changing and reconstructing analytical, astronomical, and optical science, almost defies belief. The statement could only be deemed possible by an appeal to the incontestible evidence that proves it strictly true.†

* The Nile.

† The birth of Newton was 25 Dec., 1642, (O.S.) or 5 Jan., 1643, (N.S.) In 1661, 5th June, he was entered of Cambridge, and matriculated 8 July. Before that time he had applied himself in a desultory way to parts of practical mechanics, as the movement of machines, and to dialing. As soon as he arrived at Cambridge he began to read Euclid, and threw the book down as containing demonstrations of what he deemed too manifest to require proof. It is, therefore, probable that he had before meditated upon the position and proportion of lines, perhaps of angles. Upon laying aside Euclid, he took up Descartes' Geometry, then Kepler's Optics, which he speedily mastered, as he did a book on logic, shewing the College Tutor that he had anticipated his lessons. In 1663 and 4 he worked upon series and the properties of curves. In summer, 1664, he investigated the quadrature of the hyperbolic area by the method of series which he had contrived. A paper in his handwriting dated 20 May, 1665, gives the method of fluxions, and it's application to the finding of tangents, and the

By a rare felicity these doctrines gained the universal assent of mankind as soon as they were clearly understood; and their originality has never been seriously called in question. Some doubts having been raised respecting his inventing the calculus, doubts raised in consequence of his so long withholding the publication of his method, no sooner was inquiry instituted than the evidence produced proved so decisive, that all men in all countries acknowledged him to have been by several years the earliest inventor, and Leibnitz, at the utmost, the first publisher; the only questions raised being, first, whether or not he had borrowed from Newton, and next, whether as second inventor he could have any merit at all; both which questions have long since been decided in favour of Leibnitz.*

But undeniable though it be that Newton made the great steps of this progress, and made them without any anticipation or participation by others, it is equally certain that there had been approaches in former times by preceding philosophers to the same discoveries. Cavalleri by his Geometry of Indivisibles, (1635), Roberval by his Method of Tangents, (1637), had both given solutions which Descartes could not attempt; and it is remarkable that Cavalleri regarded curves as polygons,

radius of curvature. So that at this time the direct method at least was invented. Another paper also in his handwriting Oct., 1666, gives it's application to equations involving surds.

The Optical Lectures in 1669, 70, and 71, give the doctrine of different refrangibility.—In 1665 he formed the opinion of gravitation extending to the heavenly bodies, but was prevented from drawing the conclusion definitively, by the imperfect estimate of a degree as 60 miles, to which alone he had access. After 1670, when Picard shewed it to be 69½ miles, he resumed his demonstration, and found it exact.

* Leibnitz first published his method in 1684; but he had communicated it to Newton in 1677, eleven years after the fluxional process had been employed, and been described in writing by its author.

surfaces as composed of lines, whilst Roberval viewed geometrical quantities as generated by motion; so that the one approached to the differential calculus, the other to fluxions; and Fermat, in the interval between them, comes still nearer the great discovery by his determination of maxima and minima, and his drawing of tangents. More recently Schooten had made public similar methods invented by Hudde; and what is material, treating the subject algebraically while those just now mentioned had rather dealt with it geometrically.* It is thus easy to perceive how near an approach had been made to the calculus before the great event of its final discovery.

There had in like manner been approaches made to the law of gravitation, and the dynamical system of the universe. Galileo's important propositions on motion, especially on curvilinear motion, and Kepler's laws upon the elliptical form of the planetary orbits, the proportion of the areas to the times, and of the periodic times to the mean distances, and Huygens's theorems on centrifugal force, had been followed by still nearer approaches to the doctrine of attraction. Borelli had distinctly ascribed the motion of satellites to their being drawn towards

* Cavalleri's *Exercitationes Geometricæ* in 1647, as his *Geometria Indivisibilis* in 1635, shewed how near he had come to the calculus. Fermat, however, must be allowed to have made the nearest approach; insomuch that Laplace and Lagrange have both regarded him as its inventor. He proceeds upon the position that when a Co-ordinate is a maximum or minimum, the equation, formed on increasing it by an infinitely small quantity gives a value in which that small quantity vanishes. He thus finds the sub-tangent. But perhaps his most remarkable approach to the calculus is the rule given to suppress all terms in which the square or the cube of the small quantity is found, because, it is said, those powers are infinitely small in comparison of the first power of the quantity. Thus calling that quantity e, (or as we should say d x) he considers e^2 and e^3 (d^2x and d^3x) as to be entirely rejected.—Hudde's letter to Schooten, 1658. Descartes' Geom. I. 507.

the principal planets, and thus prevented from being carried off by the centrifugal force.*

Even the composition of white light, and the different action of bodies upon its component parts, had been vaguely conjectured by Anth. de Dominis, Archbishop of Spalatro, at the beginning, and more precisely in the middle of the 17th century by Marcus, (Kronland of Prague) unknown to Newton, who only refers to the Archbishop's work; while the Treatise of Huygens on light, Grimaldi's observations on colours by inflexion as well as on the elongation of the image in the prismatic spectrum, had been brought to his attention, although much less near to his own great discovery than Marcus' experiment.†

But all this only shews that the discoveries of Newton great and rapid as were the steps by which they advanced our knowledge, yet obeyed the law of continuity, or rather of gradual progress which governs all human approaches towards perfection. The limited nature of man's faculties precludes the possibility of his ever reaching at once the utmost excellence of which they are capable. Survey the whole circle of the sciences, and

* Galileo's problem on the motion of bodies by gravity acting uniformly in parallel lines could have been no novelty to Newton; and Huygens's explanation of centrifugal tendency by the comparison of a stone's tendency to fly off when whirled round in a sling, is as correctly as possible that now received. But his theorems had been investigated by Newton several years before, as appears from a letter of Huygens himself.

† The Archbishop's explanation in 1611 of the rainbow and his experiment to illustrate it by a thin glass globe filled with water and giving colours by refraction, is remarkable; but far less so than Marcus's in 1648 on the *Iris Trigonia*, as he calls the spectrum, and his observation of the colours not changing by a second refraction, so nearly approaching Newton's *Experimentum Crucis*. It is best to mention this because writers on the history of science have so often stated that nothing like a trace of the Newtonian doctrine of light can be found in the works of former observers. There is no appearance whatever of Newton having known Marcus's work.

trace the history of our progress in each, you find this to be the universal rule. In chemical philosophy the dreams of the alchemists prepared the way for the more rational though erroneous theory of Stahl; and it was by repeated improvements that his errors, so long prevalent, were at length exploded, giving place to the sound doctrine which is now established. The great discoveries of Black and Priestley on heat and aeriform fluids, had been preceded by the happy conjectures of Newton, and the experiments of others. Nay Voltaire * had well nigh discovered both the absorption of heat, the constitution of the atmosphere, and the oxydation of metals, and by a few more trials might have ascertained it.

Cuvier had been preceded by inquirers who took sound views of fossil osteology; among whom the truly original genius of Hunter fills the foremost place. The inductive system of Bacon, had been, at least in it's practice, known to his predecessors. Observations and even experiments were not unknown to the ancient philosophers, though mingled with

* In the Prize Memoir we find (among many great errors chiefly arising from fanciful hypotheses) such passages as this observation on one of his experiments, "Il y certainement du feu dans ces deux liqueurs, sans quoi elles ne seraient point fluides;" and again, in speaking of the connexion between heat and permanent or gaseous elasticity, "N'est ce pas que l'air n'a plus alors la quantité de feu necessaire pour faire jouer toutes ses parties, et pour le degager de l'atmosphere engourdie qui le renferme." The experiments which he made on the temperature of liquids mixed together, led him to remark the temperature of the mixture as different from what might have been expected, regard being had to that of the separate liquids. Again, speaking of his experiments on the calcination of metals, "Il est tres possible que l'augmentation du poids soit venue de la matiere repandue dans l'atmosphere; donc dans toutes les autres operations par lesquelles les matieres calcinees acquierent du poids, cette augmentation pourrait aussi leur etre venue de la meme cause, et non de la matiere ignee." He had been experimenting with a view to try if heat had any weight.

(Acad. des Sciences, 1737, *Prix. IV. p.* 169.)

gross errors; in early times, almost in the dark ages, experimental inquiries had been carried on with success by Friar Bacon, and that method actually recommended in a treatise, as it was two centuries later by Leonardo da Vinci; and at the latter end of the next century Gilbert examined the whole subject of magnetic action entirely by experiments. So that Lord Bacon's claim to be regarded as the father of modern philosophy rests upon the important, the invaluable step of reducing to a system the method of investigation adopted by those eminent men, generalizing it, and extending it's application to all matters of contingent truth, exploding the errors, the absurd dogmas, and fantastic subtleties of the ancient schools, above all confining the subject of our inquiry, and the manner of conducting it, within the limits which our faculties prescribe.*

Nor is this great law of gradual progress confined to the physical sciences; in the moral it equally governs. Before the foundations of political economy were laid by Hume and Smith, a great step had been made by the French philosophers, disciples of Quesnay; but a nearer approach to sound principles

* Friar Bacon's *Opus Majus* was composed about the middle of the 13th century, certainly before 1267; and it contains among other matters connected with experimental inquiry, a treatise expressly setting forth the advantages of that mode of philosophising. His aversion to the Aristotelian errors, and his departure from the whole philosophy of the times, was probably at the bottom of the charges of heresy under which he suffered cruel persecution for so many years.—Gilbert's Treatise De Magnete et Corporibus Magneticis, was published in 1600. It is entirely founded on experiments and observations, and is called by Lord Bacon "A painful experimental work." Newton, who never alludes to Bacon, has been by some supposed not to have been acquainted with his writings. Sir D. Brewster and others have peremptorily denied that his mode of inquiry was either suggested, or at all influenced by those writings. It is certain that neither he, nor indeed any one but Bacon himself, ever followed in detail the rules prescribed in the *Novum Organum*.

had signalized the labours of Gournay, and those labours had been shared and his doctrines patronized by Turgôt when Chief Minister. Again, in constitutional policy, see by what slow degrees, from it's first rude elements—the attendance of feudal tenants at their lord's court, and the summons of burghers to grant supplies of money—the great discovery of modern times in the science of practical politics has been effected, the representative scheme, which enables States of any extent to enjoy popular government, and allows mixed monarchy to be established, combining freedom with order—a plan pronounced by the statesmen and writers of antiquity to be of hardly possible formation, and wholly impossible continuance.* The globe itself, as well as the science of it's inhabitants, has been explored according to the law which forbids a sudden and rapid leaping forward, and decrees that each successive step, prepared by the last, shall facilitate the next. Even Columbus followed several successful discoverers on a smaller scale; and is by some believed to have had, unknown to him, a predecessor in the great exploit by which he pierced the night of ages, and unfolded a new world to the eyes of the old.

The arts afford no exception to the general law. Demosthenes had eminent forerunners, Pericles the last of them. Homer must have had predecessors of great merit, though doubtless

* The opinion of Tacitus on this subject is well known. "Cunctas nationes et urbes populus, aut primores, aut singuli regunt. Delecta (some editions add, consociata) ex his et constituta rei publicæ forma laudari facilius quam evenire; vel si evenit, haud diuturna, esse potest." (Ann. IV. 33.) Cicero, in his Treatise De Republicâ, giving his opinion that the best form of government is that "ex tribus generibus, regali, optimatum, et populari, modice confusa," does not in terms declare it to be chimerical; yet he distinctly says in the same Treatise (II. 23,) that liberty cannot exist under a king. Liberty, he says, consists "non in eo ut juste utamur domino sed ut nullo."

as far surpassed by him, as Fra. Bartolomeo and Pietro Perugino were by Michael Angelo and Raphael. Dante owed much to Virgil; he may be allowed to have owed, through his Latin mentor, not a little to the old Grecian; and Milton had both the Orators and the Poets of the ancient world for his predecessors and his masters. The art of war itself is no exception to the rule. The plan of bringing an overpowering force to bear on a given point had been tried occasionally before Frederic II. reduced it to a system; and the Wellingtons and Napoleons of our own day made it the foundation of their strategy, as it had also been previously the mainspring of our naval tactics.

It has oftentimes been held that the invention of logarithms stands alone in the history of science, as having been preceded by no step leading towards the discovery. There is however great inaccuracy in this statement; for not only was the doctrine of infinitesimals familiar to it's illustrious author, and the relation of geometrical to arithmetical series well known; but he had himself struck out several methods of great ingenuity and utility, (as that known by the name of *Napier's Bones*,)—methods that are now forgotten, eclipsed as they were by the consummation which has immortalized his name.*—So the inventive powers of Watt, preceded as he was by Worcester and Newcomen, but more materially by Causs and Papin, had been exercised on some admirable contrivances, now forgotten,

* *The Rhabdologia* was only published in 1617, the year he died; but Napier had long before the invention of logarithms used the contrivances there described. His *Canon Mirificus* was only published by him in 1611; but it appears from a letter of Kepler that the invention was at least as early as 1594. The story of Longomontanus having anticipated him is a mere fable; but Kepler believed that one Byrge had at least come near the invention, and had done much certainly upon natural sines. (Epist. Leips. 1718.)

before he made the step which created the engine anew, not only the parallel motion, possibly a corollary to the proposition on circular motion in the Principia, but the Separate Condensation, and above all the Governor, perhaps the most exquisite of mechanical inventions; and now we have those here present who apply the like principle to the diffusion of knowledge, aware as they must be, that it's expansion has the same happy effect naturally of preventing mischief from it's excess, which the skill of the great mechanist gave artificially to steam, thus rendering his engine as safe as it is powerful.

The grand difference, then, between one discovery or invention and another is in degree rather than in kind; the degree in which a person while he outstrips those whom he comes after, also lives as it were before his age. Nor can any doubt exist that in this respect Newton stands at the head of all who have extended the bounds of knowledge. The science of dynamics and of optics are especially to be regarded in this point of view: but the former in particular; and the completeness of the system which he unfolded, it's having been at the first elaborated and given in perfection; it's having, however new, stood the test of time, and survived, nay gained by, the most rigorous scrutiny, can be predicated of this system alone, at least in the same degree. That the calculus, and those parts of dynamics which are purely mathematical, should thus endure for ever, is a matter of course. But his system of the universe rests partly upon contingent truths, and might have yielded to new experiments, and more extended observation. Nay, at times it has been thought to fail, and further investigation was deemed requisite to ascertain if any error had been introduced; if any circumstance had escaped the notice of the great founder. The most memorable instance of this kind

is the discrepancy supposed to have been found between the theory and the fact in the motion of the lunar apsides, which about the middle of the last century occupied the three first analysts of the age.* The error was discovered by themselves to have been their own in the process of their investigation; and this like all the other doubts that were ever momentarily entertained, only led in each instance to new and more brilliant triumphs of the system.

The prodigious superiority in this cardinal point of the Newtonian to other discoveries appears manifest upon examining almost any of the chapters in the history of science. Successive improvements have by extending our views constantly displaced the system that appeared firmly established. To take a familiar instance, how little remains of Lavoisier's doctrine of combustion and acidification except the negative positions, the subversion of the system of Stahl! The substance having most eminently the properties of an acid, (chlorine) is found to have no oxygen at all, † while many substances abounding in oxygen, including alkalis themselves, have no acid property whatever; and without the access of oxygenous or of any other gas, heat and flame are produced in excess. The doctrines of free-trade had not long been promulgated by Smith, before Bentham demonstrated that his exception of usury was groundless; and his theory has been repeatedly proved erroneous on colonial establishments, as well as his exception to it on the navigation laws; while the imperfection of his views on the nature of rent is undeniable, as well as on the principle of population. In these and such instances as these, it would not

* D'Alembert, Clairaut, Euler.

† Recent inquiries are said to have shaken if not displaced Davy's theory of chlorine.

be easy to find in the original doctrines the means of correcting subsequent errors, or the germs of extended discovery. But even if philosophers finally adopt the undulatory theory of light instead of the atomic, it must be borne in mind that Newton gave the first elements of it by the well known proposition in the VIIIth section of the second book of the Principia, the scholium to that section also indicating his expectation that it would be applied to optical science ;* while M. Biot has shewn how the doctrine of fits of reflection and transmission tallies with polarization, if not with undulation also.

But the most marvellous attribute of Newton's discoveries is that in which they stand out prominent among all the other feats of scientific research, stamped with the peculiarity of his intellectual character; they were, their great author lived before his age, anticipating in part what was long after wholly accomplished; and thus unfolding some things which at the time could be but imperfectly, others not at all comprehended ; and not rarely pointing out the path and affording the means of treading it to the ascertainment of truths then veiled in darkness. He not only enlarged the actual dominion of knowledge, penetrating to regions never before explored, and taking with a firm hand undisputed possession, ; but he shewed how the bounds of the visible horizon might be yet further extended,

* The 47th prop. lib. II, has not been disputed except as to the sufficiency of the demonstration, which Euler questioned, but without adding the proof of its insufficiency, or communicating his own process. Cramer has done both, and his demonstration is given by Leseur and Jacquier, II, 364, together with another upon Newton's principle, but supplying the defects, by the able and learned commentators. The adherents, too, of the undulatory theory have always explicitly admitted the connexion between the Newtonian experiments and their doctrine—See particularly Mr. Airey's very able Tracts—Thus, "Newton's rings have served in a great degree for the foundation of all the theories." S. 72, (p. 311, Edit. 1831.)

and enabled his successors to occupy what he could only descry; as the illustrious discoverer of the new world made the inhabitants of the old cast their eyes over lands and seas far distant from those he had traversed; lands and seas of which they could form to themselves no conception, any more than they had been able to comprehend the course by which he led them on his grand enterprise. In this achievement, and in the qualities which alone made it possible—inexhaustible fertility of resources, patience unsubdued, close meditation that would suffer no distraction, steady determination to pursue paths that seemed all but hopeless, and unflinching courage to declare the truths they led to how far soever removed from ordinary apprehension—in these characteristics of high and original genius we may be permitted to compare the career of those great men. But Columbus did not invent the mariner's compass, as Newton did the instrument which guided his course and enabled him to make his discoveries, and his successors to extend them by closely following his directions in using it. Nor did the compass suffice to the great navigator without making any observations; though he dared to steer without a chart: while it is certain that by the philosopher's instrument his discoveries were extended over the whole system of the universe, determining the masses, the forms, and the motions of all its parts, by the mere inspection of abstract calculations and formulas analytically deduced.*

The two great improvements in this instrument which have been made, the calculus of variations by Euler and Lagrange,

* The investigation of the masses and figures of the planets from their motions by Newton—the discovery by Laplace of peculiarities in those motions never before suspected, a discovery made from the mere inspection of algebraical equations, without leaving their study—are as if Columbus had never left his cabin.

the method of partial differences by D'Alembert, we have every reason to believe were known at least in part, to Newton himself. His having solved an isoperimetrical problem (finding the line whose revolution forms the solid of least resistance) shews clearly that he must have made the co-ordinates of the generating curve vary, and his construction agrees exactly with the equation given by that calculus.* That he must have tried the process of integrating by parts in attempting to generalize the inverse problem of central forces before he had recourse to the geometrical approximation which he has given, and also when he sought the means of ascertaining the comet's path (which he has termed by far the most difficult of problems,) is eminently probable, when we consider how naturally that method flows from the ordinary process for differentiating compound quantities by supposing each variable in succession constant; in short, differentiating by parts. As to the calculus of variations having substantially been known to him no doubt can be entertained.

Again, in estimating the ellipticity of the earth, he proceeded upon the assumption of a proposition of which he gave no demonstration (any more than he had done of the isoperimetrical problem) that the ratio of the centrifugal force to gravitation

* The differential equation of the curve deduced by help of the calculus of variations is of this form:—

$$y\,dy^3 = \frac{c\,(dx^2 + dy^2)^2}{dx}$$

which may be reconciled with the equation in the commentary to the Schol. of prop. XXXIV lib. II. If $p = \frac{dy}{dx}$, the equation, becomes $y = \frac{c\,(1 + p^2)^2}{p^3}$ T. Simpson in his general solution of isoperimetrical problems, (Tracts 1757) gives a method which leads precisely to the above result derived from the calculus of variations, see p. 104. See too Emerson's Fluxions, where we see his near approach to the calculus.

determines the ellipticity. Half a century later, that which no one before knew to be true, which many probably considered to be erroneous, was examined by one of his most distinguished followers, Maclaurin, and demonstrated most satisfactorily to be true.

Newton had not failed to perceive the necessary effects of gravitation in producing other phenomena beside the regular motion of the planets and their satellites, in their course round their several centres of attraction. One of these phenomena, wholly unsuspected before the discovery of the general law, is the alternate movement to and fro of the earth's axis, in consequence of the solar (and also of the lunar) attraction combined with the earth's motion. This libration, or nutation, distinctly announced by him as the result of the theory, was not found by actual observation to exist till sixty years and upwards had elapsed, when Bradly proved the fact.*

The great discoveries which have been made by Lagrange and Laplace upon the results of disturbing forces, have established the law of periodical variation of orbits, which secures the stability of the system by prescribing a maximum and a minimum amount of deviation; and this is not a contingent

* The nutation, and by name, is given in Prin: Lib. III. prop. 21, the demonstration being referred to as in Lib. I. prop. 66, cor. 20. Clairaut Princ. de Du Chatelet, tom. II. p. 72, 73, refers to the same proposition. F. Walmsly, Phil. Trans. 1746, has an excellent paper on Precession and Nutation, treated Geometrically. It is stated in Montucla IV. 216, that Roemer had given some conjectural explanation of the phenomena of what he termed *vacillation;* but no date is assigned—Roemer died in 1710. In the same passage it is said that before Bradly's discovery, Newton had "suspected the nutation." He had deduced it from the propositions above referred to, and was considered so to have done by Clairaut Bradly's paper was published in the Phil. Trans. 1747; and it is not a little singular that he makes no mention at all of Newton.

but a necessary truth, by rigorous demonstration, the inevitable result of undoubted data in point of fact, the eccentricities of the orbits, the directions of the motions, and the movement in one plane of a certain position. That wonderful proposition of Newton * which with its corollaries may be said to give the whole doctrine of disturbing forces, has been little more than applied and extended by the labours of succeeding geometricians. Indeed, Laplace, struck with wonder at one of his comprehensive general statements on disturbing forces in another proposition, † has not hesitated to assert, that it contains the germ of Lagrange's celebrated inquiry, exactly a century after the Principia was given to the world.

The wonderful powers of generalization, combined with the boldness of never shrinking from a conclusion that seemed the legitimate result of his investigations, how new and even startling soever it might appear, was strikingly shewn in that memorable inference which he drew from optical phenomena, that the diamond is "an unctuous substance coagulated;" subsequent discoveries having proved both that such substances are carbonaceous, and that the diamond is crystallized carbon; and the foundations of mechanical chemistry were laid by him with the boldest induction and most felicitous anticipations of what has since been effected. ‡ The solution of the inverse

* Lib. I. Prop. LXVI. † The XVIIth's two last Corollaries.

‡ Optics Book II. prop. 10.—It might not be wholly without ground if we conceived him also to have concluded on optical grounds, that water has some relation to inflammable substances; for he plainly says that it has a middle nature between unctuous substances and others, and this he deduces from its refractive powers, though he gives other reasons in confirmation.—In the celebrated 31st Query Book III. (p. 355,) he plainly considers rusting, inflammation, and respiration, as all occasioned by the acid vapours in which he says the atmosphere abounds.—In another place he treats of electricity as existing independent of its production or evolution

problem of disturbing forces has led Le Verrier and Adams to the discovery of a new planet, merely by deductions from the manner in which the motions of an old one are affected, and it's orbit has been so calculated that observers could find it—nay it's disc as measured by them only varies one twelve-hundredth part of a degree, from the amount given by the theory. Moreover when Newton gave his estimate of the earth's density, he wrote a century before Mackelyne by measuring the force of gravitation in the Scotch mountains, 1772, gave the proportion to water as 4,716 to 1—and many years after by experiments with mechanical apparatus Cavendish, 1798, corrected this to 5,48 and Baily more recently, 1842, to 5,66, Newton having given the proportion as between 5 and 6 times. In these instances he only shewed the way and anticipated the result of future inquiry by his followers. But the oblate figure of the earth affords an example of the same kind, with this difference that here he has himself perfected the discovery, and nearly completed the demonstration. From the mutual gravitation of the particles which form its mass, combined with their motion round it's axis, he deduced the proposition that it must be flattened at the poles; and he calculated the proportion of it's polar to it's equatorial diameter. By a most refined process he gave this proportion upon the supposition of the mass being homogeneous. That the proportion is different in consequence of the mass being hetereogenous does not in the least affect the soundness of his conclusion. Accurate measurements of a degree of latitude in the equatorial and polar regions, with experiments on the force of gravitation in those

by friction. Black always spoke of that Query with wonder, for the variety of original views which it presents on almost every branch of chemical science.

regions, by the different lengths of a pendulum vibrating seconds, have shewn that the excess of the equatorial diameter is about eleven miles less than he had deduced it from the theory; and thus that the globe is not homogeneous: but on the assumption of a fluid mass, the ground of his hydrostatical investigation, his proportion of 229 to 230 remains unshaken; and is precisely the one adopted and reasoned from by Laplace, after all the improvements and all the discoveries of later times. Surely at this we may well stand amazed, if not awe struck.* A century of study, of improvement, of discovery has passed away; and we find Laplace, master of all the new resources of the calculus, and occupying the heights to which the labours of Euler, Clairaut, D'Alembert, and Lagrange have enabled us to ascend, adopting the Newtonian fraction of one two-hundred-and-thirtieth, as the accurate solution of this speculative problem. New admeasurements have been undertaken upon a vast scale, patronised by the munificence of rival governments; new experiments have been performed with improved apparatus of exquisite delicacy; new observations have been accumulated, with glasses far exceeding any powers possessed by the resources of optics in the days of him to whom the science of optics, as well as dynamics, owes its origin; the theory and the fact have thus been compared and reconciled together in more perfect harmony; but that theory has remained unimproved, and the great principle of gravitation, with it's most

* The wholly erroneous measurement of an arc by the two first Cassinis, (Dominic and James) was supposed to prove the shortening of the degree towards the poles, in opposition to the Newtonian theory. But all doubt on the subject was set at rest by the admeasurement in Peru in 1735, and in Lapland in 1736, and in France more recently. But the error of Dominic and James Cassini was also corrected by the Cassini de Thury, who found that it had arisen from an imperfect measure employed.

sublime results, now stands in the attitude, and of the dimensions, and with the symmetry, which both the law and it's application received at once from the mighty hand of it's immortal author.

But the contemplation of Newton's discoveries raises other feelings than wonder at his matchless genius. The light with which it shines is not more dazzling than useful. The difficulties of his course, and his expedients, alike copious and refined for surmounting them, exercise the faculties of the wise, while commanding their admiration ; but the results of his investigations, often abstruse, are truths so grand and comprehensive, yet so plain, that they both captivate and instruct the simple. The gratitude, too, which they inspire, and the veneration with which they encircle his name, far from tending to obstruct future improvement, only proclaim his disciples the zealous because rational followers of one whose example both encouraged and enabled his successors to make further progress. How unlike the blind devotion to a master which for so many ages of the modern world paralysed the energies of the human mind !—

> " Had we still paid that homage to a name
> Which only God and nature justly claim,
> The western seas had been our utmost bound,
> And poets still might dream the sun was drown'd,
> And all the stars that shine in southern skies
> Had been admired by none but savage eyes."

Nor let it be imagined that the feelings of wonder excited by contemplating the achievements of this great man are in any degree whatever the result of national partiality, and confined to the country which glories in having given him birth. The language which expresses her veneration is equalled, perhaps exceeded, by that in which other nations give utterance to

theirs; not merely by the general voice, but by the well considered and well informed judgment of the masters of science. Leibnitz, when asked at the royal table in Berlin his opinion of Newton, said that "taking mathematicians from the beginning of the world to the time when Newton lived, what he had done was much the better half." "The Principia will ever remain a monument of the profound genius which revealed to us the greatest law of the universe,"* are the words of Laplace. "That work stands pre-eminent above all the other productions of the human mind. † "The discovery of that simple and general law by the greatness and the variety of the objects which it embraces confers honour upon the intellect of man." ‡ Lagrange, we are told by Delambre, was wont to describe Newton as the greatest genius that ever existed, but to add how fortunate he was also, "because there can only once be found a system of the universe to establish." § "Never," says the father of the Institute of France, one filling a high place among the most eminent of its members—"Never," says M. Biot, "was the supremacy of intellect so justly established and so fully confessed. || In mathematical and in experimental science without an equal and without an example; combining the genius for both in its highest degree." †† The Principia he terms the greatest work ever produced by the mind of man, adding in the words of Halley that a nearer approach to the divine nature has not been permitted to mortals. ‡‡ "In first giving to the world Newton's method of fluxions, says Fontenelle, Leibnitz did like Prometheus; he stole fire from

* Syst. du Monde V. 5. † Ib. V. 5.

‡ Ib. IV. 5. § Mem. de L'Instit. 1812. p. XLIV.

|| Journ. de Sav. 1852, p. 135. †† Ib. 1852, p. 279.

‡‡ Ib. 1855, p. 552. Nec fas est propius mortali attingere divos.

Heaven to teach men the secret."* "Does Newton," L'Hopital asked, "sleep and wake like other men? I figure him to myself as of a celestial kind, wholly severed from mortality."

To so renowned a benefactor of the world, thus exalted to the loftiest place by the common consent of all men, one whose life without the intermission of an hour was passed in the search after truths the most important, and at whose hands the human race had only received good, never evil, those nations have raised no memorial which erected statues to the tyrants and conquerors, the scourges of mankind, whose lives were passed not in the pursuit of truth but the practice of falsehood, across whose lips, if truth ever chanced to stray towards some selfish end, it surely failed to obtain belief; who to slake their insane thirst of power, or of pre-eminence, trampled on all the rights, and squandered the blood of their fellow creatures; whose course, like the lightning, blasted while it dazzled; and who, reversing the noble regret of the Roman Emperor, deemed the day lost that saw the sun go down upon their forbearance, no victim deceived, or betrayed, or oppressed. That the worshippers of such pestilent genius should consecrate no outward symbol of the admiration they freely confessed, to the memory of the most illustrious of men, is not matter of wonder. But that his own countrymen, justly proud of having lived in his time, should have left this duty to their successors, after a century and a half of professed veneration and lip homage, may well be deemed strange. The inscription upon the Cathedral, masterpiece of his celebrated friend's architecture, may possibly be applied in defence of this neglect. "If you seek for a monument, look around."† If you seek for a

* Acad. de Sciences, 1727.

† Si monumentum quæris, circumspice. (on Wren in St. Paul's.)

monument, lift up your eyes to the heavens which shew forth his fame. Nor when we recollect the Greek orator's exclamation, "The whole earth is the monument of illustrious men,"* can we stop short of declaring that the whole universe is Newton's. Yet in raising the Statue which preserves his likeness near the place of his birth, on the spot where his prodigious faculties were unfolded and trained, we at once gratify our honest pride as citizens of the same state, and humbly testify our grateful sense of the Divine goodness which deigned to bestow upon our race one so marvellously gifted to comprehend the works of infinite wisdom, and so piously resolved to make all his study of them the source of religious contemplations, both philosophic and sublime.

* Pericles. (Thuc. II. 43.)

Beside the remarkable solution of T. Simpson, p. 91, his Tracts contain other singular anticipations.—A very learned person (Mr. Jerwood of Exeter,) has pointed out a distinct anticipation of Lagrange's celebrated formula on the stability of the System. Nothing can be more delightful than contemplating the success of self-taught men, as Emerson was nearly—T. Simpson altogether—and both in humble circumstances.

SPEECHES

DELIVERED AT THE DEJEUNER, AFTER THE INAUGURATION OF THE STATUE.

THE REV. W. WHEWELL, D.D.,

MASTER OF TRINITY COLLEGE, CAMBRIDGE,

In replying to the toast of "The University of Cambridge," said—

Considering what is the occasion which assembles us here to day, I cannot affect to think it strange, or to regret, that I should be invited to take a share in the ceremonial; at least if I am to be regarded in any degree as the representative of the University of Cambridge and of Trinity College in that University. For that University and College have on all occasions and from the earliest period shown the most lively sympathy in the discoveries and in the fame of Newton. Professor Owen has told you of the cordial good-will and gratitude with which the Royal Society of London received the discoveries of Newton. I may tell you of the admiration which was felt for Newton even before his great discoveries were published—of the zeal and reverence with which they were accepted by his contemporaries in the College, and in the University—and of the manner in which ever since their publication we have there been engaged in the study of his doctrines. To many persons here, perhaps, it may not occur how close are the ties which connect

a Fellow with his College. For purposes such as that of the present occasion the tie is closer even than that of the natural family. With those who thus belong to us we share as it were an *intellectual* blood. We have in common with them our pursuits, our lines of reading, our books, our chambers, where we study at the very desks at which they have studied. In our cloisters, and our groves, where they paced to and fro weaving their speculations, we still pace to and fro, trying to solve the difficulties which their speculations involve. We feel as if Newton had passed from among us only yesterday. We still point out his chambers—we shew his works, his manuscripts, his instruments, locks of his silvery hair. We—I speak on the part of the College, and of the University—acknowledged his greatness before it was known to the world. Barrow, soon afterwards the Master of the College, resigned the Professorship of Mathematics in his favour. The College excused him all the usual college labours as officer. We swelled the shout of admiration and applause with which all his discoveries were from the first received. We have on all occasions rejoiced to join in every proceeding of which the object was to do honour to his name, and therefore we most willingly join in this; and as I have said, we cannot think it strange that our sympathy should be expected and called for on the occasion of erecting his statue here. We have long had our statue of him—a statue erected soon after his death—and which the greatest portrait statuary of our time, I mean Chantrey, has repeatedly told me he thought the finest portrait statue in England. We rejoice to think that another statue of admirable design and workmanship commemorates him here. We regard Cambridge as more especially the birthplace and the home of his intellectual life and scientific fame; we as gladly recognise the connection which other places may

claim with him, and on the present occasion Grantham in particular.

I have spoken of the reception of Newton's philosophy at Cambridge. If the time allowed, and if you would bear with me for a few instants deviating somewhat from the commonplace of an occasion like this, I should be glad to mention a few particulars respecting the reception of new discoveries at Cambridge in Newton's time, which so far as I know, no one else can at this moment tell you. I will explain how this is. In Trinity College we are, thanks to the liberality and college love of an illustrious and accomplished nobleman, (the Marquis of Lansdowne) about to erect a statue to Barrow, whom I have already mentioned, as you are this day erecting a statue to Newton; and we are also about to issue from our University press a new and I hope much improved edition of the Works of Barrow. This has led us to read with care Barrow's Works, and amongst them there are some, namely, speeches and compositions on public occasions in the University, which throw a curious light on the progress of Cambridge opinions respecting natural philosophy. You all know that Descartes was one of the great early lights of modern philosophy; who claiming the right, or rather asserting the duty, of rejecting authority and forming our opinions for ourselves, is supposed to have overthrown the authority of Aristotle, and given the great impulse to modern thought: this was the character of Descartes on the continent, and is so to this day. You know perhaps also that he devised a system of mechanism in which he explained the motions of the planets, not by attraction, as Newton did afterwards, but by *vortices* which carried them round like straws in a whirlpool: on this account Descartes was for a time an object of ridicule and dislike to the English philosophers as Newton was to the Continental ones,

during the reign of the Cartesian hypothesis. Now this being the case, What line did the Cambridge men take? Precisely that which was most reasonable and sagacious. They took the good parts of the Cartesian system, and rejected the bad. There is a copy of Latin verses by Barrow on some public occasion (the most eminent men then wrote Latin verses on all public occasions) of which the subject is Descartes and the Cartesian philosophy; and in these verses he speaks with admiration of Descartes as the bold assertor of freedom of thought, and as the strong man who broke down the tyranny of authority; but, he says, that freedom of thought which you have taught us, we exercise towards yourself; and admiring your character, we accept your doctrine in part only. And the doctrine of vortices was so far from being among the parts adopted, that it was never even mentioned, and was not even understood to be included when the Cartesian philosophy was spoken of, as Barrow's expressions in this and other places clearly show. What was understood by the Cartesian philosophy was the explanation of phenomena by the doctrine of mechanics, hydrostatics, and the like, in which Descartes had real merit, for he first gave an exact explanation of the rainbow, though it was left for Newton to explain the origin of the colours. But what I have said may explain how little obstacle to the reception of the Newtonian doctrine at Cambridge there was in the prevalence of the Cartesian system.

Indeed if I might be allowed to make another remark, I should say that if there be an opinion generally current, as sometimes there seems to be, that great discoveries are generally received with opposition and ill-will, this opinion is, I conceive, so far as England is concerned, altogether erroneous. Here at least we have had no "Martyrs of Science." All

the great discoveries of our time, as the atomic theory of Dalton, the alkaline metals of Davy, the magnetic spark of Faraday, have been received with universal applause. The undulatory theory of optics is scarcely an exception. And the same has been the case in past times. In the instance which has been adduced to the contrary, the discovery of the circulation of the blood by Harvey, the discovery was almost at once accepted by all men of eminence. Harvey was unanimously elected president of the College of Physicians—his bust was placed in their hall—he was supplied freely with deer from the royal park for important anatomical purposes. The only material inconvenience which he suffered was that his anatomical collections were pillaged and destroyed by the Parliamentary army—for no man worthy to be a votary of truth can think an important evil the discussions and argumentations which must take place before new truths can be generally understood. And so in the case of Newton's great discoveries on the mechanism of the universe, their reception was everywhere eager and cordial, especially at Cambridge. The paper in which he explained the principles of these discoveries was carried to London by a Fellow of one of the Colleges of Cambridge, who in delivering the paper to the Royal Society, spoke of the greatness and value of the discoveries. The Principia, the great work in which it was delivered as a separate treatise, very soon rose to many times the original price, though Newton for many years could not be prevailed upon to publish a new edition. Other works founded upon it were published by other persons—as Whiston and Gregory. Bentley, in seven years from the publication, made a popular view of these discoveries the subject of lucid and forcible sermons, and was soon after appointed to the mastership of Newton's college, where he used

his office to promote the study of Newton's philosophy. Newton was soon after elected Member of Parliament for the University, and held in the highest honour till he removed to London; and from that time is spoken of by members of the college as an object of unbounded reverence whenever they have occasion to refer to him. From that time to the present we have been employed in studying and illustrating his discoveries; and if there be any blame which may justly be thrown upon us, it is that our reverence for Newton long prevented us from doing justice to his successors in other centuries.

It is known to many of you that among the grounds of the wonder with which we look at Newton's achievements in calculation and demonstration, one is, the instrument with which he performed those achievements. All his calculations and demonstrations were presented to the public not by means of algebra and written symbols, as now the like results are commonly obtained; but by geometry such has had been used from the times of the first Greek Geometers without the aids of modern analytical calculations. It is as if some great General of our own time had gained his victories without the aid of gunpowder. Nobody since Newton has been able to use geometrical methods to the same extent for the like purposes; and as we read the Principia we feel as when we are in an ancient armoury where the weapons are of gigantic size; and as we look at them, we marvel what manner of man he was who could use as a weapon what we can scarcely lift as a burthen. Since Newton's time, the methods of obtaining the like results have been made to proceed by algebraical symbols, and far be it from us to deny the beauty and the power of those methods. Yet still the best mathematicians feel an interest in Newton's intellectual processes, and still try to make

them intelligible to common readers. Among those who have made this attempt is the noble and learned Lord who has been so worthily elected to preside on this occasion, and whose exposition of the Principia has been read at Cambridge as much as at any other place.

I will beg your patience while I refer to one other feature of Newton's character and of Newton's great book the Principia, which it would not be well on any such occasion to omit to notice. He, the discoverer of the laws of nature, was constant, clear, definite, emphatic, in his habit of looking up to the Author of nature and Legislator of her laws. He who explored the principles which govern the universe, always carried his thoughts to the Maker and Governor of the universe. He recognised not only a law of nature but a law of man; not only a creative and sustaining power, but a providential government. This is a striking and leading feature in Newton's speculations, and his exposition of them; and tempting as the subject is, and willingly as I could further expatiate upon it, I will here conclude what I have to say.

I will only add the toast which I am authorised to propose. I am sure that the scholars of the school in which Newton pursued his school-boy studies must have felt, that by the proceedings of this day there is a dignity given to all learning and to all study, which may animate and elevate their exertions in their school career. I have to propose prosperity to the school and the health of the Master.

THE REV. J. W. INMAN,

MASTER OF GRANTHAM SCHOOL,

In replying to the toast proposed by Dr. Whewell, said—

It has been a great honour, Sir, to the Grammar School to be permitted to take so prominent a part in to-day's procession, but to be called upon to lift even one voice at this triumphant festival is a greater, perhaps too great an honour. There are dignities, there are preferments which oppress and overwhelm those who occupy them. It is even so with us. We are like those golden argosies, of which poets sing, labouring beneath the weight of their precious burden, and tottering to the port. "*Nec jam sustineant onus.*" But, Sir, to my mind there has been much of solemnity in the whole progress of this enterprise. It was begun in humility, it was carried on in patience, and at the hour of its successful issue there were present many elements of religious awe. When the heroic effigy of our illustrious countryman rose to its feet, night had already drawn her veil over the earth, and the moon,—his moon, (if I may say so without blasphemy) lit up her torch to prolong the day, and aid the workmen's labours, while in the west there shone that flagrant planet, whose terrors he had done so much to disarm: from every portion and quarter of the starlit sphere there seemed to crowd celestial witnesses to testify to the importance of the event, and bid us worship in silence the mighty

spirit of the dead. But Sir, "*conamur tenues grandia :*" we must not prattle long on so stupendous a theme. The ingenious poet, who sang the praise of Newton, contracted his thoughts within two nervous lines. Let us imitate his brevity. We are thankful that we have taken a part in this great undertaking : we are thankful that we have been present at this celebration : but our thanks are most particularly due, Sir, to you and this numerous company for the kindness and courtesy with which you have drank our healths.

SIR B. C. BRODIE, BART., F.R.S.,

In responding to the toast "Prosperity to the Royal Society of London," said—

I have been called upon to respond in the name of the Royal Society to the toast which has just been proposed. In one respect I feel that I may not improperly do so. I was a very young man when the Royal Society did me the honor of electing me to be one of their fellows: and very many years having elapsed since that time, the result is, that there are not (as I believe) more than three or four persons who have been fellows of the society longer than myself. Of the few who are my seniors in the list of the society, one is now present among us. The noble Lord, whose eloquent address we have this day heard, is the author of a paper which was communicated to the Royal Society nearly sixty three years ago, and which was published soon afterwards in the Philosophical Transactions. I need not tell you how Lord Brougham has been constantly engaged ever since in the advancement of all kinds of knowledge :—mathematics ; natural philosophy ; law ; political economy ; moral philosophy ; every one of these having more or less occupied his attention. It has seldom happened that any one has enjoyed the amount of either health or intellect required to be thus actively and usefully employed during so long a series of years.

About two hundred years have now elapsed since a small band of philosophers first assembled in a room in Gresham College for the purpose of making experiments in physics, and mutually receiving and communicating knowledge in what are called the natural sciences. Two or three years afterwards they received a charter of incorporation from his majesty King Charles the second. Such was the humble origin of the Royal Society. At that time there were few who sympathized with them in their pursuits, and there were not wanting those among the presumptuous and ignorant who turned them into ridicule. It was not so however with the sovereign by whom the society was founded, to whom, whatever may be the case with others, we at least are bound to express our obligations. In the early part of his reign he showed an earnest desire to promote the objects which the society had in view, and in the charter which he granted he evinced a just appreciation of the genius of the English people. When Louis the 14th, nearly forty years afterwards, established the Royal Academy of Sciences of Paris, he made one class of its members pensioners of the state, and he required that no one should be admitted into the academy until his election had been confirmed by the Crown. It is not for us to find fault with the constitution of a society which has attained for itself so high a reputation; which has so largely contributed to the advancement of knowledge, and which has the most illustrious names in Europe enrolled in the list of its members. But thus much we may say, that such a constitution would not have suited the Royal Society. In the charter granted by King Charles the second it was left altogether to the management of its own affairs. It was made a wholly independent body, free from all interference on the part of the crown or of any of the higher powers of the state. The result has

been that it has never been influenced by political factions, nor has ever been mixed up with the party politics of the day; and that the only relation which it has borne to numerous successive governments has been that of amity founded on a mutual exchange of good offices.

If any one of that small band of philosophers, to whom I have alluded as holding their unostentatious meetings in Gresham College, could now revisit the earth, we may well conceive how much he would be gratified by witnessing the proceedings of this day. He would learn that instead of being limited to a few persons, the desire of knowledge pervades the length and breadth of the land, and that there is no class of the community which does not more or less participate in it. To say that all that has been done in science in this country during the last two hundred years is to be attributed to the Royal Society would be an absurdity. In the progress of human society, as ordained by a higher power, the time had arrived when the physical sciences so long neglected should become objects of interest and study, and the Royal Society was but one in the chain of events belonging to this movement. But having been once established, it became an efficient instrument in carrying on the movement in which it had itself originated. It has been the means of bringing those engaged in similar pursuits into friendly communication with each other; and of exciting a spirit of emulation among them; and it has moreover placed an honourable distinction within the reach of all those whose talents and labours have contributed to the enlargement of the boundaries of knowledge.

That mighty genius whose vast achievements we have this day heard so eloquently described, was an early fellow of the Royal Society. He presided over it for twenty-four years, and

many of his discoveries are recorded in the Philosophical Transactions. You will I am sure do the society the justice to believe, that there is no one among its fellows who does not sympathize with those who are here assembled to do honor to the memory of Sir Isaac Newton; and in the name not only of those who are now present, but also in that of those who are absent, I thank you for the kind manner in which the toast proposed by Mr. Owen has been received.

T. WINTER, ESQ.,

HONORARY SECRETARY,

In responding to the compliment paid him by Dr. Latham in proposing his health, said—

I cannot but deeply feel the high compliment which has just been paid to me, and I regret extremely that no language of mine can adequately express my thanks for the honour which has been done to me on this interesting occasion. Those who know me are aware that deeds rather than words have been my forte through life—not that I take any merit to myself for this, for, after all, it is but the instinct of profession. In the work which we have seen so happily completed to-day, I have, from the moment that it was first suggested, taken the greatest delight; and therefore, though it has not been accomplished without to me labour and trouble, yet has it been to me a "labour of love," and if the part which I have played in it has met with the approval of my friends and neighbours, then am I amply rewarded. Vain, however, would have been my humble efforts had it not been for the deep sympathy and noble assistance which a bare mention of a memorial to our illustrious countryman at once called forth. If you desire to know to whom I now allude, look at the list of subscribers—from her most gracious Majesty to her humblest subject—from the school-boy to the senator—to all the name of Newton was a talisman! Were I to particularize, it would indeed be a difficult task, yet I cannot refrain

from mentioning a few names to whose special advice and assistance the success of this work is mainly due—my Lord Rosse, the late Earl Fitzwilliam, our noble Lord Lieutenant, the Earl of Harrowby, the Hon. Sir Edward Cust, who has been a host in himself, the Master of Trinity, the Rev. J. Edleston of the same college, and Dr. Latham. Indeed I find it most difficult where to stop, but above all others, my guiding star has been the truly great and noble lord who has taken so important a part in the proceedings of the day; and here I would also tender to every member of the two committees, and to my fellow labourers the several secretaries, my sincere thanks for their courteous and kind assistance throughout. To attempt any remarks upon the life or character of the great philosopher would in me be insufferable presumption; but the lines which appear over the head of our worthy Chairman call to my mind the far more beautiful words which were uttered by the dying philosopher:—"I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the sea shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than usual, whilst the great ocean of truth lay all undiscovered before me." These are the words which, if any in addition to the name of Newton, I could wish to see written in letters of gold upon his monument—they are deeply suggestive, and not only were they prophetic of the vast discoveries which have been made since the day they were spoken, but they still point onwards and tell us how much we have yet to learn. Aud now, with your permission I would revert for a moment to the list of Subscribers; you have all seen the list which was published. The funds at our command, paid up or promised, were then below the required amount. Such I am glad to inform you will no longer be the case when

all the promised subscriptions are received. For this happy consummation we are not a little indebted to the family of a gentleman who is with us to-day; and one also in whose veins run some of the Newton blood. The family to which I allude is that of Mr. Vignoles, the celebrated Civil Engineer. That gentleman at one time fully intended to have been present, but not being able to carry out that intention, he has sent to us one of his sons, and with him to make up our deficiency the munificent sum of £50, in addition to his first subscription, as well as most liberal subscriptions from all his three sons. I now, therefore, propose that we drink the "health of all absent subscribers," and with this toast I will couple the name of the Reverend Olinthus Vignoles.

CONCLUDING REMARKS.

Having thus given the Inaugural Oration and Speeches with which we have been kindly permitted to honour our pages, we cannot bring our labours to a conclusion without expressing the great satisfaction we have derived from the success which attended the Inauguration of the Statue. The Committee of Management, aided by their enthusiastic Secretary, Mr. Winter, deserve the highest credit for the manner in which the programme of the day was drawn up. Everything was well arranged; each part of the proceedings was appropriate to the others; and while there was not too much of action so as to cause fatigue, there was quite enough of it to keep up a sustained interest. The weather was, most fortunately, all that could be desired for the celebration of an English out-door festival. That those who were to take part in the ceremony should assemble in the Grammar School, was a happy idea, and the meeting of so many men of learning, science, and influence within the very walls in which the school days of the illustrious Philosopher they came to honour were passed, was a felicitous commencement of the proceedings of the day.

The interest which the event had excited was manifest on all sides: men of the highest standing in the world of science eagerly travelled from distant parts of the kingdom to assist in a ceremonial so honourable to all concerned in it; and almost every person of the upper and middle classes in the vicinity of Grantham made it a point to attend. Never before were the streets of the town so crowded as on this occasion by persons to whom the word "respectable" in all its peculiarly English signification could be so properly applied, and it was through a multitude of spectators of this class that the well-arranged procession wended its way to St. Peter's Hill, where, in front of that admirable specimen of high art, the Statue of Sir Isaac Newton, surrounded by the authorities of the town and county, and cheered by a sympathising audience seated on a platform which had been most appropriately divided into compartments, each ornamented with a different colour of the prism, the venerable statesman, savant, and orator, Brougham, delivered the words of wisdom which we have been permitted to add to our work.

Then followed the Dejeuner, of which 400 ladies and gentlemen partook, and at which those present had the gratification and advantage of listening to speeches of a high character delivered by some of the leading men of the day, all expressing their full concurrence with the great object they had met to celebrate. The whole proceedings were brought to a conclusion by a Conversazione at the Town Hall, where by a further display of that liberality, courtesy, and good taste which he had manifested at every stage of the undertaking, the Mayor, John Lely Ostler, Esq., ensured a most agreeable evening to all who had attended the Dejeuner, and to several

others who had not had that pleasure. Truly Tuesday the 21st of September, 1858, is a day much to be remembered in the annals of Grantham.

S. Ridge & Son, Steam Press Office, Grantham.